DUKE ELECTRIC TRANSMISSION FACILITY CONNECTION REQUIREMENTS

August 21, 2008

REVISIONS

REVISION NUMBER	DATE	REASON FOR REVISION		
0		Approved by SERC		
11	8/5/01	Include specific generator reactive support requirements in section IV.D.6.c		
2	9/10/03	Clarify load connection requirements in section III.C.2. Clarify joint study requirements in section III.B and IV.B. Add statement that future project data changes may require additional study of impact.		
3	8/25/06	Reformatting only of fonts and alignment. No technical changes.		
4	10/1/06	Added section III D 1 i and associated definitions		
5	12/1/06	Revised sections III.D.1.d and IV.D.1.e requirements for voltage flicker per IEEE Standard 1453-2004.		
6	6/20/08	Section III E-4 "Protective System Coordination", additional clarifying language.		

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I. INTRODUCTION

Standard I.C.S1 of the NERC (North American Electric Reliability Council) *Planning Standards* issued September, 1997 state that Facility Connection Requirements for all facilities involved in the generation, transmission, and use of electricity be documented. All electric industry participants are required to document the facility connection requirements for their system.

Duke Electric Transmission (Duke ET) has prepared this document to identify technical requirements for connecting load deliveries, generation facilities, and control area Interconnections to the Duke Electric Transmission System (Duke ET System) which typically consists of 44-, 100-, 230-, and 500-kV transmission lines and stations. This document is divided into two major sections: 1) Load Delivery Requirements and 2) Generation and Interconnection Requirements. Important terms used in this document are capitalized and Italicized (e.g. Project, Project Sponsor, Connection Point) and explained in the Definitions section. Some projects may have both load and generation on site. Load Delivery Requirements apply to projects having generating capability of less than 25% of minimum load. These technical requirements are designed to ensure the safe operation, integrity, and reliability of the Duke ET System.

These requirements do not supersede existing contracts such as the Catawba Agreements. The document may be used to interpret some of the provisions of existing contracts, for example, where "Prudent Utility Practice" applies. The document can also be used in developing contracts, operating agreements, etc. to specify requirements of individual projects connecting to the Duke ET System. These requirements will be adhered to for all connections, including those owned by Duke Energy.

Technical requirements are addressed, but contractual matters, such as costs, ownership, leasing options, scheduling, and billing are not the focus of this document. In general, the *Project Sponsor* assumes the cost of all design, construction, inspection, analysis, maintenance, operations, monitoring, and all associated facilities needed to satisfy the technical requirements identified for integration of the *Project* into the *Duke ET System*. Enforcement of these requirements will be covered in the contracts, operating agreements, and/or other legal documents applicable to the specific *Project*.

The *Project Sponsor* submits the proposal for a new *Project. Duke ET* evaluates these proposals on a case-by-case basis and specific connection requirements are provided accordingly. Physical laws that govern the behavior of electric systems do not recognize boundaries of electric facility ownership. Thus, to properly design a connection, the electric systems must be studied and analyzed without regard to ownership. *Duke ET* will study any proposed-connection to its system using existing and forecasted system data and data supplied by the *Project Sponsor*. In these studies, *Duke ET* considers short-circuit duties, transient voltages, reactive power requirements, stability requirements, harmonics, safety, operations, maintenance and *Prudent Electric Utility Practices*. *Duke ET* will develop connection proposals for review with the *Project Sponsor*.

This document is not intended as a design specification or an instruction manual. Technical requirements stated herein are intended to be consistent with North American Electric Reliability Council (NERC) and Southeastern Electric Reliability Council (SERC) planning and operating policies, principles, practices, and standards. Compliance with NERC standards is expected and nothing in this document relieves the *Project Sponsor* of the industry expectation to meet them. The information presented in this document is subject to change.

II. DEFINITIONS

Important terms used in this document are capitalized and Italicized (e.g. *Project, Project Sponsor, Connection Point*) and defined in this Section.

For industry standard definitions of electric industry terminology, please refer to:

The New IEEE Standard Dictionary of Electrical and Electronic Terms, IEEE Std 100-1992.

For the purposes of this document the following definitions apply:

Absolute Voltage Limits - The upper and lower voltage operating limits of each bus on the system. The absolute voltage limits are expressed as a percent of Duke's nominal voltage. The system is managed such that all voltages should be maintained within the appropriate absolute voltage bounds for all conditions.

Bulk System - The portion of the *Duke Electric Transmission System* used for transferring large amounts of power and includes all 500-kV lines, 500-kV substations, 500/230-kV transformers, and 230-kV lines.

Connection Point - The physical location on the power system of the change of ownership between *Duke ET* and the *Project* or *Interconnecting Utility*.

Connection Review – The review of a *Project* proposal to connect to the transmission system. This includes all studies required by the Tarlff along with verification that all technical requirements in this document are properly addressed.

Contingency Voltage Drop - The decrease in voltage due to a single contingency.

Customer Equivalent – Power Delivery Asset Management methodology used to normalize customers of unequal size. Customers are converted to "customer equivalents". For large customers, divide the peak KWD by 5 KW.

Duke Electric Transmission (Duke ET) – Business unit responsible for the planning and operation of the *Duke Electric Transmission System*.

Duke Electric Transmission System (Duke ET System) - The integrated electrical transmission facilities owned by Duke Energy including primarily 500-kV, 230-kV, 100-kV, and 44-kV lines and stations.

Effectively Grounded - A system that provides an $X_0/X_1<3$ & $R_0/X_1<1$ where X_0 and R_0 are zero sequence reactance and resistance, and X_1 is positive sequence reactance.

Equivalent Fault – A fault of sufficient magnitude and duration to trip a utility owned line or circuit protective device, whether such a protective device exists or not.

Incapacitating Disturbance – For a customer, a power problem equivalent in effect and severity to a sustained outage, and not limited to equipment malfunctions (e.g. severe "flicker" disturbs humans, not machines). Typical examples are sustained outages, momentary Interruptions; and severe voltage sags. These disturbances must be shown to cause the customers a problem.

Infeed – Contribution from a positive or zero sequence source, a transformer or generator, to a fault.

Interconnection - Transmission system tie point between two control areas.

Joint Use Breaker Agreement – Legal document specifying details between *Duke ET* and a *Project Operator* regarding the operation and control of equipment (e.g., circuit breaker) that is accessible to both parties.

Interconnecting Utility - The utility that owns the transmission or distribution system that connects the *Project* to the *Duke Electric Transmission System* at the *Connection Point*.

MAIFI - refers to the average number of momentary interruptions per year.

Momentary interruptions - Outages, zero voltage, lasting 1 minute or less.

NERC - North American Electric Reliability Council and its successors

Planning Standards - Duke Electric Transmission Planning Guidelines document, which is part of Duke's annual FERC 715 filing, the *SERC* Planning Principles and Guides, or the *NERC* Planning Standards.

Project - The load delivery, *Interconnection*, or generation facility and all equipment associated with integration of the *Project* up to the *Connection Point* with *Duke Electric Transmission System*. None of the facilities that make up the *Project* are owned by *Duke Electric Transmission*.

Project Operator - The company that operates a load delivery, *Interconnection*, or generation facility.

Project Sponsor - A company that owns and/or develops a new load delivery, *Interconnection* or generation facility.

Protection Station - Facility that satisfies the requirements necessary to provide complete protection for the *Project* immediately beyond the *Connection Point*.

Prudent Electric Utility Practices or Prudent Utility Practice - The generally accepted design, practices, methods, and operation of a power system, to achieve safety, dependability, efficiency, and economy, and to meet utility and industry codes, standards, and regulations.

Reliability and Integrity – Aspects of the transmission system that affects the customer outage experience and concerns the safe maintenance of utility assets, in good working condition, at the lowest overall cost while preserving corporate reputation.

SAIFI - The average number of sustained interruptions per customer per year.

SCADA (Supervisory Control and Data Acquisition) - A system of remote control and telemetry used to monitor and control the transmission system.

SERC - Southeastern Electric Reliability Council

Station Service - The electric supply for the ancillary equipment used to operate a generating station or substation.

SOC – Duke Energy's System Operating Center located in Charlotte, NC responsible for generator dispatch and control area monitoring.

Sustained Outages - Outages, zero voltage, lasting for more than 1 minute.

TCC - Duke Energy's Transmission Control Center located in Charlotte, NC.

Voltage Regulation - The difference between expected maximum and minimum voltages at any particular delivery point. The voltage regulation limits are expressed as a percent of the nominal voltage and are defined for both normal and contingency conditions. Voltage regulation for delivery point voltages should not exceed the guidelines.

Voltage Unbalance - The percent deviation of one phase rms voltage value from the average of all three phases' rms voltage values.

III. FACILITY CONNECTION REQUIREMENTS - LOAD DELIVERIES

A. Scope

The technical requirements contained herein generally apply to all load deliveries connected to the *Duke ET System* except those noted in the Introduction. The location of the delivery and the Impacts on the *Duke ET System*, or another utility's system, determine the specific requirements. The *Project* must not degrade the safe operation, integrity, or reliability of the *Duke ET System*.

Applicable Codes, Standards, Criteria and Regulations

To the extent that the Codes, Standards, Criteria and Regulations are applicable, the *Project* shall be in compliance with those listed in the References section of this document and others that are applicable.

· Safety, Protection, and Reliability

Duke ET, after consultation with the *Project Sponsor* and other relevant parties, shall make the sole and final determination as to whether the *Duke ET System* is properly protected from any problems that the *Project* might cause before a connection is closed. The *Project Sponsor* is responsible for correcting such problems before connected operation begins. The *Project Sponsor* is responsible for safety, protection, and reliability on the *Project* side of the *Connection Point*.

Non-Duke ET Responsibilities

Project Sponsors and Project Operators shall comply with NERC Planning Standards and Operating Policies. The Project Sponsor is responsible for the planning, design, construction, reliability, protection, and safe operation of non-Duke ET System-owned facilities. This will normally require the Project to Include a Protection Station immediately beyond the Connection Point. The design and operation of the Project is subject to applicable local, state and federal statutes and regulations.

• Cost of Connection Reviews

The *Project Sponsor* requesting *Duke ET* to perform a *Connection Review* will reimburse *Duke ET* for its actual costs to perform the study. This includes costs associated with verifying that all technical requirements in this document are properly addressed.

B. Connection and System Impact Studies and Project Sponsor-Supplied Information

Project Sponsors should contact Duke Electric Transmission as early as possible in the planning process for any potential new or modified load connection to the Duke ET System. The Project Sponsor should not make its own assumptions about the final location, voltage, or connection requirements. Certain areas within the Duke ET System can accept only limited amounts of additional load without costly reinforcements. Duke ET may have to add to or modify its transmission system substantially before connecting a new Project. A Connection Review must be performed to determine the required connection facilities and modifications to accommodate the Project. This study may also address the transmission system capability, transient stability, voltage stability, losses, voltage regulation, harmonics, voltage flicker, electromagnetic transients, ferroresonance, metering requirements, protective relaying, substation grounding, and fault duties. If necessary, joint study with neighboring control areas may be performed to assess the impact of the Project. The data that the Project Sponsor is required to provide to enable the completion of these studies is listed in the Project Sponsor Supplied Information section.

Part of the Connection Review will include a high level review of the design, construction, maintenance, and operation rules and standards that will be used before and after connection is made to the Duke ET System. If any portions of this review need further investigation or justification to prove all facility connection requirements will be met, it will be the responsibility of the Project Sponsor to provide the necessary Information to illustrate the justification or provide an alternative solution to meet the facility connection requirements. This high level review is intended to identify moderate to major discrepancies and the Project Sponsor remains responsible for meeting the facility connection requirements before and after connection is made to the Duke ET System regardless of the results of the Connection Review.

1. Connection Configuration

Projects may be connected to the Duke ET System by tapping an existing transmission line(s) or by connecting directly into an existing transmission station. In rare instances, a new transmission switching station may be built in the middle of an existing transmission line. Load deliveries are almost always connected to Duke ET System's 100-kV and 44-kV transmission systems. Duke ET System's 500-kV and 230-kV transmission systems are typically reserved for the bulk transport of large amounts of electricity. The number of available connection options is dependent upon many factors, including location of the desired Connection Point relative to existing Duke ET System transmission facilities, the size of the Project's load, and other requirements of the Project. The most feasible option(s) will be considered in the Connection Review, with the most economic option meeting all requirements being selected.

2. Power Flow

The *Project* is incorporated into power flow models by *Duke ET* using the data provided by the *Project Sponsor*. Power flow simulations are performed to determine the Impact of the *Project* on the transmission system. The primary intent is to determine if the new load causes any violations of the Duke Electric Transmission Planning Guidelines (Planning Guidelines), which is part of Duke's annual FERC 715 filling, the *SERC* Planning Principles and Guides, or the *NERC Planning Standards* (collectively, *Planning Standards*). A summary of these guidelines is provided below:

a. Thermal and Voltage Screening

The purpose of this study is to ensure that the connection of the *Project* does not create any thermal loadings or voltage levels outside of the limits provided in the Planning Guldelines. *Project* information obtained from the *Project Sponsor* is used to model the *Project*. Power system simulation tools are used to model a wide range of transmission system operating conditions to determine the thermal loading and voltage level changes created by the *Project* on the *Duke ET System*.

b. Transfer Capability

The purpose of this study is to ensure that the connection of the *Project* does not reduce any Transfer Capabilities below limits provided in the Planning Guldelines. Power transfers are simulated across the *Duke Electric Transmission System* in various directions to determine how the *Project* affects *Duke ET System*'s ability to transfer power across its system.

3. Protection

After studying the possible ways to connect the *Project* to the *Duke ET System*, the protective requirements will be determined. This will include an impedance model at the *Connection Point* (short-circuit data), protective changes to the transmission system, protective requirements for the delivery and any special protective needs for the *Project*. See the General Requirements and Protection Requirements sections for more details on these requirements.

4. Power Quality and Reliability

There is a very diverse set of users connected to the *Duke ET System* with differing system requirements. In the past, most customers were only concerned with extended interruptions. However, the increased use of highly sensitive power electronic devices within all customer sectors has changed the definition of reliability. Due to the sensitivity of many industrial and commercial loads such as adjustable speed drives (ASDs) and computer controlled processes, reliability is no longer only defined by the frequency and duration of sustained interruptions. There are many power quality variations other than sustained interruptions that may constitute inadequate service for the proper operation of customer equipment. Variations such as *Voltage Unbalance*, voltage flicker, harmonic distortion, transient overvoltages, temporary overvoltages and steady-state voltage regulation can adversely affect customer processes.

The challenge for the transmission owner is to design and operate the transmission system such that it meets the requirements of this diverse set of users. To meet this challenge, *Duke Electric Transmission* performs studies to determine the power quality and reliability impacts of any new *Project* on the *Duke ET System* at the *Connection Point*. The intent of these studies is to ensure that the connection of the *Project* does not compromise the reliability and integrity of the *Duke ET System*.

The studies performed for each new Project may include:

a. Voltage Unbalance

The purpose of this study is to ensure that the operation of any new *Project* does not create a *Voltage Unbalance* condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the

Project Sponsor is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of Voltage Unbalance created by the Project at the Connection Point.

b. Voltage Flicker

The purpose of this study is to ensure that the operation of any new *Project* does not create voltage fluctuations in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of voltage fluctuations created by the *Project* at the *Connection Point*.

c. Harmonic Distortion

The purpose of this study is to ensure that the operation of any new *Project* does not create harmonic current injections in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of harmonic distortion created by the *Project* at the *Connection Point*.

d. Transient Overvoltage

The purpose of this study is to ensure that the operation of any new *Project* does not create a transient overvoltage condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of transient overvoltages created by the *Project* at the *Connection Point*.

e. Temporary Overvoltage

The purpose of this study is to ensure that the operation of any new *Project* does not create a temporary overvoltage condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of temporary overvoltages created by the *Project* at the *Connection Point*.

f. Temporary Undervoltage

The purpose of this study is to ensure that the operation of any new *Project* does not create a temporary undervoltage condition in excess of the limits provided in the *Performance* Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of temporary undervoltages created by the *Project* at the *Connection Point*.

g. Insulation Coordination

The purpose of this study is to ensure that the operation of any new *Project* does not create a condition that will require intervention of *Duke ET System*-owned transmission equipment in excess of the limits provided in the Performance Requirements section.

5. Changes to Project Sponsor-Supplied Information

If any data previously supplied pursuant to these connection requirements changes, the *Project Sponsors* or *Project Operator* will notify *Duke ET* in writing without delay. Data changes may require additional studies to examine the impact. This notification will include:

- the time and date at which the change became, or is expected to become, effective
- if the change is only temporary, an estimate of the time and date at which the data will revert to the previously supplied form.

A request for a change in *Connection Point* to the *Duke ET System* must be submitted as a new request. A new completion date will be negotiated with the *Project Sponsor* or *Project Operator* when *Project* data is changed.

Duke ET will request load growth projections after the initial connection is made. This will require an annual submittal for the *Project* detailing the load projections for each of the next 5 years.

6. Required Project Sponsor-Supplied Information

Any Project Sponsor desiring a new connection or modification of an existing connection must provide the following information:

- Facility name and contact name
- 2. Address
- 3. Phone number, fax number, e-mail address of contact name
- 4. Effective date of new connection or modification
- 5. Proposed location of Project
- 6. One-line diagram of Project
- 7. Preferred supply voltage
- 8. Load demand under normal and emergency conditions
- Power factor
- 10. Expansion plans (type and size of potential loads)
- Transmission line voltage, conductor rating, impedance, length, insulation, grounding, etc.
- 12. Transformer ratings, connections, voltage taps, impedances, and grounding
- 13. Lightning protection designs for transmission lines and stations
- 14. Special requirements (e.g. sensitive equipment, dual feeds, etc.)
- 15. Preferred method of connection (series, automatic high side swapover, etc.)
- 16. Relay schemes, relay settings, protection equipment
- 17. Maintenance schedules and procedures

For industrial plants served directly from the *Duke ET System*, or for load serving entitles serving large industrial plants close to the *Duke ET System*, the following additional information is needed:

1. One-line diagram of plant distribution system and loads

Power factor correction capacitors size, connection, and control scheme

3. In-plant switchgear and protective device information

Motor application/loads, rate horsepower, rated voltage, type (synchronous, induction), starting frequency, full load current, locked rotor current, power factor, efficiency, starting time (starting current versus time curves), etc.

5. Method of motor starting

6. Size, location, and characteristics of single-phase loads

- Size, location, and characteristics of large fluctuating loads (arc furnaces, welders, etc.)
- 8. Size, location, and characteristics of harmonic producing loads (variable speed drives, induction furnaces, etc.)

Size, method of operation, and location of on-site generation

10. Size, location, and characteristics of power conditioning equipment

C. General Requirements

1. Safety

All safety and operating procedures for joint use equipment shall be in compliance with the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.269, the National Electrical Safety Code (NESC), the <u>Duke Power Safe Work Practices Manual</u>, the <u>Duke Electric Transmission Operating Procedures Manual</u> and the *Project Sponsor's* safety manuals.

a. Isolation Requirements

The *Project Operator* shall not energize any *Duke ET System* line or equipment unless the Duke Transmission Control Center (*TCC*) specifically approves energization. If, for any reason, a protective device operation separates the *Project* from the *Duke ET System*, the *Project Operator* will contact the Duke *TCC* before attempting to restore the connection to the *Duke ET System*.

At the Connection Point with the Duke ET System, a disconnect switch shall be provided for the purpose of physically and visibly isolating the Project from the Duke ET System. With the consent of Duke ET and the Project Sponsor, the disconnect switch may be installed at another location, other than the Connection Point, provided that the purpose described herein is satisfied. The device:

- Must be accessible by Duke ET and under Duke TCC jurisdiction.
- If gang-operated, must be lockable in the open position by Duke ET.
- Must be suitable for safe operation under the conditions of use.
- Would not be operated without advance notice to either party, unless an
 emergency condition requires that the device be opened to isolate the
 Project.

Duke ET personnel may open the switch:

- If it is necessary for the protection of Duke ET maintenance crew personnel when working on de-energized circuits.
- If the Project or Duke ET System equipment presents a hazardous condition.

Consideration shall be given as to the design and capacity of the switch on a case-by-case basis. The switch is required for safety and may not be required to interrupt load or energization (charging) current. However, a suitable switch for the safety requirements herein described may also be used to provide for other operational purposes.

b. Generation Served by the Project

The *Project Sponsor* shall maintain a record of all generation customers served by the *Project* and such record shall be made available to *Duke ET*. For the requirements of energized line maintenance or line construction on the *Duke ET System*, the *Project Sponsor* will ensure that all generation customers served by the *Project* will disconnect their generation upon request by *Duke ET*.

2. Connection Point Considerations

a. Protection and Monitoring of the Project

The Project Sponsor and/or Project Operator are responsible for protecting the Project from fault conditions and other undesirable conditions (e.g., single phasing). The Project Sponsor must demonstrate that the entire Project is protected from fault conditions before connection will be made. This includes providing adequate protection for any transmission line sections that are part of the Project. The Project Sponsor and/or Project Operator will also be responsible for monitoring the Project to demonstrate that the Project performance criteria are being met. A Protection Station at the Connection Point is a common prerequisite to meet these requirements.

The Project Sponsor may arrange alternate arrangements with the transmission provider to provide protection for portions of the Project although the responsibility is still with the Project Sponsor to provide protection. However, monitoring is required to measure performance at the Connection Point. Although "low-side" meters may be used to help calculate parameters at the Connection Point such as power factor and voltage flicker, they can not indicate items such as faults on the source side of the meters or temporary undervoltages at the Connection Point. The Project Sponsor is encouraged to meet these requirements using any means necessary although at this point in time, a Protection Station appears to be a prerequisite to meeting both the protection and monitoring requirements set forth in these facility connection requirements.

b. General Configurations and Constraints

Integration of *Projects* into the *Duke ET System* usually falls into one of two categories:

- 1) Connection into a 44-kV or 100-kV substation, with (depending on the bus configuration) the transmission lines terminated into one or more breakers. Switching station buses are either double-bus or breaker-and-a-half arrangements. Connection at voltages below 44-kV are not usually considered part of the transmission system, even at stations that have voltages of 44-kV or higher.
- 2) Connection at 44-kV or 100-kV by tapping a transmission line. This tap may be as simple as tying hard and fast to the conductor where

isolating switches are immediately adjacent in the substation, or may be as complex as requiring a new switching station in the transmission line.

c. Special Configurations and Constraints

The constraints and considerations described below may substantially affect the costs of a particular integration plan, sometimes making an alternate Connection Point for the Project more desirable.

1) Connection to the Bulk System

Duke Power's transmission system may be separated by function into two main parts: the Bulk System (230 kV and 500 kV networks) and the Regional System (44 kV, 66 kV, 100, and 161 kV networks). Each part of the transmission system plays an important role in the delivery of energy from generators to end-users. The Regional System is a group of electric transmission lines and tie-stations whose primary function is the distribution of energy to large industrial and large commercial customers and to retail stations in its geographical area. The Bulk System is a highly Inter-connected group of high-voltage electric transmission lines and tie-stations whose purpose is to enable the movement or transfer of electric energy in bulk between generators and major points of delivery. To accomplish this function effectively, the Bulk System has been designed and built to maintain the integrity and security of the interconnected generation and transmission network. The following list describes some of the major functional and design differences of the Bulk System compared to the Regional System: the Bulk System provides the primary means for bulk energy transfer across the SERC Region supporting Eastern Interconnection reliability, allows energy from dispersed generation to be moved over large geographical areas supporting economic dispatch and reliable system operation during generation contingencies; allows bulk energy to be transported with lower line losses reducing the overall cost of energy; and, the much reduced number of taps and stations on the Bulk System lowers exposure to faults and equipment fallures, resulting in fewer disturbances that adversely impact generation reliability. As a result of the function of the Bulk System, individual load connections to transmission lines are not allowed because of the overall detrimental affect on system reliability.

2) Connection to 100- and 44-kV Lines

Most *Projects* are connected to the *Duke ET System* with a *Connection Point* at one of these voltages. A radial extension of the line can be provided to reach the *Project*. Some lines have two circuits available from a double-bussed substation arrangement such that several special service arrangements are available at additional cost. Almost all 44-kV lines are operated radially without this option available.

3) Connection to Network Lines

Duke ET will own and operate any equipment in series with a transmission line that is part of the Duke ET System. Therefore, any equipment that is required for connection of a Project that will be in series with a transmission line will be owned and operated by Duke ET. This

includes radial sections of transmission lines that carry load for more than one Connection Point.

4) Multi-Terminal Lines

A multi-terminal line can be defined as a customer connection that could back feed to a Duke transmission line. The sources could be generators, connections to other parts of the power system, or ground sources (e.g., transformers connected grounded-wye at the connection voltage). These types of terminals affect Duke ET's ability to protect, operate, dispatch, and maintain the transmission line. The increased complexity of the control and protection schemes affects system stability and reliability. Duke ET determines the feasibility of multi-terminal line connections on a case-by-case basis, often relying on the results of Connection Studies. If such a connection would have an unacceptable impact on the Duke ET System, a substation at the transmission voltage level would need to be developed.

d. Other Considerations

Below are some of the other issues considered when evaluating *Project* proposals:

1) Equipment

Existing electrical equipment, such as transformers, power circuit breakers, disconnect switches, and line conductors were purchased based on existing and forecast system conditions. However, with the connection of new loads, some equipment may become overloaded and need to be replaced. All equipment purchased by *Duke ET* and the *Project Sponsor* as part of the *Project* must meet the applicable NESC and all appropriate IEEE standards for equipment testing and application. *Duke ET* reserves the right to review and set forth requirements for the specification and application of all equipment used in the *Project* that could impact the Performance Requirements for the *Project*.

2) System Stability and Reliability

The *Duke ET System* has been developed with careful consideration for system stability and reliability during disturbances. The size of the *Project*, equipment configurations, and the ability to set protective relays will affect where and how the *Connection Point* is made. The *Project* may also be required to participate in special protection schemes.

3) Control and Protection

Duke ET coordinates its protective relays and control schemes to provide for personnel safety and equipment protection and to minimize disruption of services during disturbances. *Project* connection usually requires the addition or modification of protective relays and/or control schemes. This may also include the use of communication channels to provide protection for tap lines, dual customer feeds, generation or other special requirements of the customers. New *Projects* must be compatible with existing protective relay schemes. *Duke ET System* uses a pilot tripping

scheme on all 500-kV, 230-kV lines and some 100-kV lines. A conventional zone protection is usually used at 100-kV and below. The *Project* shall not provide a ground source at any voltage level unless specifically approved and coordinated with *Duke ET*.

4) Protection Stations

A major purpose of the *Protection Station* is to provide the primary protection requirements for the *Project. Protection Stations* must provide adequate protection to all of the *Project* facilities as stated in the Protection Requirements section without relying on any *Duke ET System* protective devices to provide primary protection beyond the *Connection Point*. The other purposes of the *Protection Station* include preventing *Duke ET System* facilities from being interrupted for faults within the *Project*, controlling reclosing practices when testing lines, monitoring equipment for Performance Requirements, and metering requirements. It is possible that *Duke ET*, or another company, will provide and operate the *Protection Station* for the *Project Sponsor*. The Sponsor will be held responsible for its design, construction, testing, maintenance, operation, and all associated costs with these activities.

Duke ET reserves the right to review and set forth requirements for the specification and coordination of the Protection Station. These stations must be designed such that the Project Operator and Duke Electric Transmission can have access to and control of the station. A Joint Use Breaker Agreement, or similar agreement, will be developed to allow Duke ET to operate and control this station under certain specified conditions. Duke ET may modify the reclosing requirements after connection is made if the Project fails to meet any of the provisions in the Performance Requirements section of this document. Duke ET may also require a dedicated set of current transformers that can be used by Duke ET to set relays to monitor and control the Protection Station if any of the provisions in the Performance Requirements are not met.

Duke ET reserves the right to require protective stations at any Connection Point before or after Initial connection is made to the Duke ET System. Duke ET may install its own Protection Station, at the Project Sponsor's expense, if the provisions in the Performance Requirements section are violated on a regular basis.

5) Phase Orientation

Duke ET uses a phase rotation of ZYX (phase "Z" voltage leads phase "Y" voltage by 120 degrees). It is important that the *Project Sponsor* and *Project Operator* understand this phase sequence and coordinate with *Duke ET* before connection is made to ensure intended phase rotation is achieved. *Duke ET* can typically provide the phase sequence desired by the project sponsor at 100kV, however there may be limitations in a given *Project. Duke ET* cannot guarantee a requested phase sequence connection until each connection request is reviewed in detail. *Duke ET* will not typically "roll phases" at the *Connection Point* for a *Project* unless *Duke ET* did not provide adequate or accurate information regarding the phase sequence to be provided at the *Connection Point*.

6) Outage Coordination & Maintenance

Duke ET operates and maintains its system to provide reliable customer service while meeting the seasonal and dally peak loads even during equipment outages and disturbances. Project integration requires that the equipment at the Project not restrict timely outage coordination, automatic switching or equipment maintenance scheduling. Preserving reliable service to all Duke ET System customers is essential and may require additional switchgear, equipment redundancy, or bypass capabilities at the Project for acceptable operation of the Duke ET System.

7) Atmospheric & Seismic

The effects resulting from wind storms, floods, lightning, altitude, temperature extremes, and earthquakes must be considered in the design and operation of the *Project*. The *Project Sponsor* is responsible for determining that the appropriate standards are met, including, but not limited to, the Uniform Building Code (UBC) and the National Electrical Safety Code (NESC). Depending on *Project* location, size, type, and importance, *Duke ET* may request that additional capabilities be designed into the *Project*. Lightning is one of the most predominant causes of transmission line outages in the *Duke ET System* service area and can be mitigated with proper design and grounding improvements. The *Project Sponsor* is expected to design its power system to withstand reasonable lightning activity as is typical to the area in which it will be installed and still meet the Performance Requirements for the *Project*.

3. Substation Grounding

Each generation site and/or connecting substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment which are in, or immediately adjacent to, the station under normal and fault conditions.

If the Project is physically close to another substation, it is recommended that the two ground grids be connected. The interconnecting cables must have sufficient capacity to handle fault currents and control ground grid voltage rises. Duke ET must approve any connection to a Duke substation ground grid. If the ground grids must be isolated for operational reasons, there must be no metallic ground connections between the two substation ground grids. Cable shields, cable sheaths, station service ground sheaths, and overhead transmission shield wires can all inadvertently connect ground grids. Fiberoptic cables are an excellent choice for telecommunications and control between two substations to maintain isolated ground grids. In the case where the Project is physically close to another substation but the ground grids are isolated, the Project Sponsor must demonstrate that the ground grids are properly isolated and in compliance with all applicable codes and standards. Duke ET prefers to connect static wires on incoming transmission lines to the station ground grid. If the Project Sponsor prefers not to connect static wires on incoming transmission lines to the station ground grid; the Project Sponsor must notify Duke ET in writing and demonstrate that relay performance, lightning protection, and personnel safety are not compromised by isolating the static wires from the station ground grid.

The *Project* ground grid should be designed to ANSI/IEEE Std. 80-1986, IEEE Guide for Safety in AC Substation Grounding, and should be measured in accordance with IEEE - 81 Part 1: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Potentials and Part 2: Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems. Project grounding requirements shall also comply with the National Electrical Safety Code, ANSI/IEEE - 665 Guide for Generating Station Grounding, IEEE - 837 Standard for Qualifying Permanent Connections Used in Substation Grounding, IEEE - 487 Protection of Wire-Line Communication Serving Electric Power Stations, ANSI/IEEE 367-1987 IEEE Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault, and any applicable state and local codes.

4. Insulation Coordination

Power system equipment is designed to withstand voltage stresses associated with expected operation. Connection Reviews include the evaluation of the impact of the Project on equipment insulation coordination. Duke ET identifies additions required to maintain an acceptable level of Duke ET System availability, reliability, equipment insulation margins, and safety.

Voltage stresses such as lightning surges, switching surges, temporary overvoltages, and normal 60Hz voltages may affect equipment duty. Remedies depend on the equipment capability and the type and magnitude of the stress. Below are the requirements that must be met to connect to the *Duke ET System*. In general, stations shall be protected against lightning and switching surges. Typically this includes station shielding against direct lightning strokes, surge arresters on all wound devices, and shielding on the incoming lines.

a. Lightning Surges

Lightning is the single largest cause of transmission line events in the *Duke ET System* service area and must be considered during the design and Installations of transmission lines and substations. Lightning related causes are not exempt from the requirements in the Performance Requirements section. Although it is not always cost effective to design and build a power system to withstand every possible lightning stroke, it has been demonstrated that with proper design and installation procedures, the effects of lightning can be mitigated to achieve a reliability level equal to or exceeding the *Project* performance criteria defined in the Performance Requirements section. Techniques used to help control lightning related events on transmission lines include proper use of shield wires, insulation levels, low resistance grounding, and surge arresters. Techniques used to help control lightning related outages in substations include substation shielding, proper arrester applications, and shielding of incoming transmission lines.

If the *Project* proposes to tap a Duke transmission line that is shielded, the new tap line must also be properly shielded for at least one mile from the *Duke ET System*. If any stations are within one mile of the *Duke ET System*, these also must be properly shielded from direct lightning strokes. The *Project Sponsor* must be able to demonstrate proposed designs for any transmission lines and substations will perform within the limits for service interruptions as stated in the Performance Requirements section.

For transmission line design, an industry recognized lightning performance estimating algorithm may be used to demonstrate acceptable performance of the

design. The *Project Sponsor* must make reasonable assumptions based on the area that the transmission line will be installed including ground flash density and grounding conditions. The *Project Sponsor* must be able to provide an alternative plan if the ground conditions required for acceptable performance are not achieved during construction of the transmission line. For substation design, the *Project Sponsor* must be able to demonstrate their proposed designs will operate within the performance requirements. The shielding designs and arrester applications shall adhere to applicable IEEE standards. In addition, any normally open points that are subject to voltage "doubling" of incoming lightning surges must be considered and protected accordingly so the Performance Requirements are not violated.

b. Switching Surges

At voltages below 500-kV, modifications to protect the *Duke ET System* against *Project*-generated switching surges are not anticipated although the *Connection Review* identifies the actual needs. At 500-kV, *Duke ET* may require that arresters be added at the line terminations of the substations if switching surge studies predict overvoltages that may otherwise cause a flashover at the *Project's* facilities.

c. Temporary Overvoltages

Temporary overvoltages can last from cycles to minutes, and are not characterized as surges. These overvoltages are usually present during faults and other abnormal system conditions. The *Duke ET System* is typically considered *Effectively Grounded* at 100-kV and higher voltages. However, the 44-kV system is not *Effectively Grounded* in all locations. These systems may be impedance grounded and can have line to ground voltages approaching 1.73 times normal line to ground voltage during fault conditions on unfaulted phases. It is not acceptable for the *Project* to supply any ground source for the transmission system unless specifically approved and coordinated with *Duke ET*.

A system study may be performed for each *Project* based on the point on the *Duke ET System* that is being connected. The *Project Sponsor* will be supplied the system characteristics needed to calculate the temporary overvoltages that need to be considered. Gapless metal-oxide surge arresters are especially sensitive to system temporary overvoltages and *Duke ET* may review the specification of arresters used on 44-kV systems to ensure proper application.

d. Normal Operating Voltages

The *Duke ET System* voltages are normally operated within the limits specified in the Performance Requirements section of this document. Insulation Coordination usually does not need to consider this operating range once lightning and switching surge requirements are met; however, in highly contaminated areas, special consideration and additional insulation requirements may be required for proper insulation coordination. The *Project Sponsor* is responsible for determining whether special insulation requirements are needed for its system.

5. Inspection, Testing, Calibration and Maintenance

The *Project Sponsor* and *Project Operator* have full responsibility for the inspection, testing, calibration and maintenance of its equipment, up to the *Connection Point*, consistent with the power purchase, operating agreement or connection agreement.

Maintenance activities must be coordinated with the *Project* and *TCC* and/or *SOC* to ensure the *Duke ET System* is not adversely affected.

a. Preenergization Inspection and Testing

Before initial *Project* energization, the *Project Sponsor* or *Project Operator* shall develop an Inspection and Test Plan for preenergization and energization testing. This plan should include provisions for testing protective equipment that comply with the *NERC Planning Standards*, Section III A, Guide G9. *Duke ET* will review and must approve the test plan prior to the test. *Duke ET* may require additional tests; the costs of these tests are subject to negotiation. The Sponsor shall make available to *Duke ET* all drawings, specifications, and test records of the *Project* equipment pertinent to connected operation.

b. Calibration and Maintenance

1) Revenue Metering

Revenue metering shall be tested and calibrated if necessary at least every two years. More frequent test intervals may be negotiated. All Interested parties or their representatives may witness the calibration tests. Calibration records shall be made available to all interested parties. The Metering and Telecommunication Requirements section should be reviewed for further details.

2) All other equipment

The *Project Sponsor* or *Project Operator* shall implement a preventive maintenance program for the *Project* equipment. The program shall be designed and executed in a manner to ensure the proper operation of the *Project* equipment. The program may be based on time or on other factors, including performance levels or reliability. Appropriate equipment performance data will be collected and maintained by the *Project Sponsor* or *Project Operator*. *Duke ET* reserves the right to review the preventive maintenance program for the *Project*. Maintenance records of the *Project* equipment pertinent to connected operation shall be made available to *Duke ET* upon request.

6. Station Service

Power provided for local use at a substation to operate lighting, heat and auxiliary equipment is termed Station Service and will be required at all Protection Stations. Appropriate providers of Station Service are determined during the Project planning process. Generally, the utility with a distribution service in the area will be the preferred provider of Station Service. The Project Sponsor may need to provide metering for Station Service depending on the provider of Station Service.

Alternate Station Service is a backup source of power used only in emergency situations or during maintenance when primary Station Service is not available. Alternate Station Service is usually only used in large stations.

D. Performance Requirements

All Projects must be properly designed, constructed, operated, and maintained to avoid degrading the reliability of the Duke ET System. A Project must comply with the Project performance criteria, listed below, and must be able to operate satisfactorily within the limits defined in the Duke ET System Characteristics section, below, in order to be considered properly connected. The Project Sponsor or Project Operator is expected to demonstrate, through monitoring, that the Project meets the Performance Criteria. It is required that the criteria of Sections 1.a, 1.b, and 1.c (below) be monitored. The remaining criteria must be met and considered in the design and operation of the Project although these do not necessarily have to be monitored. However, if problems are suspected at any time, Duke ET may require the Project Sponsor and/or Project Operator to demonstrate through monitoring the performance of the Project at the Connection Point meets these requirements.

If the requirements are not met, the *Project Sponsor* or *Project Operator* must demonstrate to *Duke ET* a plan to improve and meet the performance criteria. Relay and control requirements may be developed and enforced by *Duke ET* after connection is made if these performance criteria are violated. Enforcement of these performance criteria and penalties associated with them are beyond the scope of this document and will be in *Project*-specific contracts and operating agreements.

1. Project Performance Criteria

To ensure the reliability and integrity of the supply system, all *Projects* must meet the *Project* performance criteria at the *Connection Point*. The following section details the *Project* performance criteria.

a. Power Factor

Projects that serve primarily distribution load (retail stations, wholesale customers, etc.) must comply with the following power factor requirements measured at, or compensated to the Connection Point:

Peak Periods - The *Project* must operate its electrical system in a manner resulting in a power factor not less than 96.5% lagging at the hour of transmission system peak load on an annual basis.

Valley Periods - The *Project* must operate its electrical system in a manner not resulting in a leading power factor at the hour of transmission system valley load on an annual basis.

b. Transmission System Interruptions

For Connection Points at 100kV and below, the Project shall not cause an interruption to any portion of the Duke ET System more than once in a 12-month period, more than three times in a five-year period, or more than five times in a ten year period. For Connection Points at voltages higher than 100kV, requirements will be determined on a case-by-case basis. An interruption is defined as a voltage zero condition lasting greater than 20 milliseconds. Interruptions occurring within one minute of each other will be considered the same event. Exemptions are not typically given, even for lightning or other weather related causes. A Project is in violation of the Project performance criteria if these requirements are not met.

c. Temporary Undervoltages

For Connection Points at 100kV and below, the Project may not cause a temporary undervoltage at the Connection Point more than two times in a 12-month period, more than five times in a five-year period, or more than eight times in a ten year period. For Connection Points at voltages higher than 100kV, requirements will be determined on a case-by-case basis. A temporary undervoltage is defined as an oscillatory phase-to-ground or phase-to-phase voltage of 85% or less of nominal voltage lasting greater than 20 milliseconds occurring during fault conditions. Undervoltages due to non-fault events are covered in the voltage flicker requirements. Temporary undervoltages occurring within one minute of each other will be considered the same event. A Project is in violation of the Project performance criteria if these requirements are not met.

d. Voltage Flicker

Per IEEE Standard 1453-2004, planning levels of $P_{\rm sl}$ =0.8 and $P_{\rm ll}$ =0.6 define the allowable voltage fluctuation limits at the *Connection Point*. In unique cases, higher limits can be considered with the understanding that the customer operating the disturbing load will be required to mitigate the flicker that they cause, if significant customer complaints are generated. Additionally, any single customer that creates disturbances for other customers will be required to mitigate the disturbance, regardless of the actual measured value.

Operation of the system or equipment in such a manner as to create a voltage fluctuation greater than 3% on the transmission system or on the primary of the distribution system is not allowed.

e. Harmonic Content/Harmonic Distortion

The maximum allowable harmonic current injections (percentage harmonic distortion at each frequency as a function of maximum load current) at the *Connection Point* for *Projects* connected at 230-kV or 500-kV, 100-kV, and 44-kV are defined in Table 1, Table 2, and Table 3, respectively. Operation of the system or equipment in such a manner as to create a condition where the harmonic current injection at the *Connection Point* exceeds the limits provided for in Tables 1, 2, and 3 for a duration greater than or equal to one hour on any single day or exceeds 150% of the limits provided for the given connection voltage for a duration greater than five minutes on any two days during a six month period is in violation of the *Project* performance criteria.

Table 1. Current Injection Harmonic Distortion Limits: Connection Point Voltage >161000 V

Individual Harmonic Order (Odd Harmonics)						
Isc/Iload	H<11	11≤h<17	17≤h<23	23≤h<35	h>35	TDD
<50	2.0 %	1.0 %	0.75 %	0.3 %	0.16 %	2.5 %
≥50	3.0 %	1.5 %	1.15 %	0.45 %	0,22 %	3.75 %

Notes: Even harmonics are limited to 25% of the odd harmonic limits above

Current distortions that result in DC offset are not allowed

I_{load} is the maximum load current (fundamental frequency component) at the *Connection Point*

I_{sc} is the maximum short-circuit current at the Connection Point

TDD (Total Demand Distortion) is the total harmonic current distortion expressed in % of maximum demand load current

Table 2. Current Injection Harmonic Distortion Limits: Connection Point Voltage 69001 V to 161000 V

Individual Harmonic Order (Odd Harmonics)						
Isc/Ibad	H<11	11≤h<17	17≤h<23	23≤h<35	h≥35	TDD
<20	2.0 %	1.0 %	0.75 %	0.3 %	0.15 %	2.5 %
20<50	3.5 %	1.75 %	1.25 %	0.5 %	0,25 %	4.0 %
50<100	5.0 %	2.25 %	2.0 %	0.75 %	0.35 %	6.0 %
100<1000	6.0 %	2.75 %	2.5 %	1.0 %	0.5 %	7,5 %
>1000	7.5 %	3,5 %	3.0 %	1.25 %	0.7 %	10.0 %

Table 3. Current Injection Harmonic Distortion Limits: Connection Point Voltage 120 V to 69000 V

Individual Harmonic Order (Odd Harmonics)						
Isc/Iload	H<11	11≤h<17	17≤h<23	23≤h<35	h≥35	TDD
<20	4'.0 %	2.0 %	1.5 %	0,6 %	0.3 %	5.0 %
20<50	7.0 %	3.5 %	2.5 %	1.0 %	0.5 %	8,0 %
50<100	10.0 %	4.5 %	4.0 %	1.5 %	0.7 %	12.0 %
100<1000	12.0 %	5.5 %	5.0 %	2.0 %	1.0 %	15.0 %
>1000	15.0 %	7.0 %	6.0 %	2.5 %	1.4 %	20.0 %

f. Voltage Unbalance

The maximum Voltage Unbalance any Project is allowed to introduce on the Duke ET System at the Connection Point is 1%. Any Voltage Unbalance condition greater than 1% that has a duration greater than or equal to one minute is in violation of the Project performance criteria.

g. Temporary Overvoltages

The *Project* may not operate its equipment or system in such a manner as to cause a temporary overvoltage at the *Connection Point* greater than or equal to 120% of the nominal system voltage. A temporary overvoltage is defined as an

oscillatory phase-to-ground or phase-to-phase overvoltage lasting greater than 20 milliseconds which is undamped or only weakly damped. Any temporary voltage condition caused by the operation of the *Project's* equipment that results in a temporary overvoltage greater than or equal to 120% of the nominal system voltage at the *Connection Point* is in violation of the *Project* performance criteria.

h. Transient Overvoltages

The *Project* may not operate its equipment or system in such a manner as to cause a peak transient voltage at the *Connection Point* greater than or equal to 140% of the nominal peak voltage. A transient overvoltage is defined as the peak line-to-line or line-to-ground voltage during the transient conditions resulting from operation of a switching device. Any transient voltage condition caused by the operation of the *Project's* equipment that results in a peak transient voltage greater than or equal to 140% of the nominal peak voltage at the *Connection Point* is in violation of the *Project* performance criteria.

I. Standards for Degradation of Transmission System Reliability and Integrity by Customers

This section prescribes a comprehensive approach for limiting the degradation of transmission system *Reliability and Integrity* by customers while the sections immediately preceding address some specific areas of interest. In any case, the more stringent limitation applies.

Customers shall not cause power disturbances on the *Duke ET System* that exceed any of the annual limits listed below. Customers exceeding any of these annual limits shall be considered to have violated the Standards for Degradation of Transmission System *Reliability* and *Integrity* (R&I) by Customers.

- Creation of more than 0.0067 Sustained Outages per 1 MW of customer's load (SAIFI of 0.0067 per MW load).
- Creation of more than 0.0333 Momentary Interruptions or Equivalent Faults per 1 MW of customer's load (MAIFI of 0.0333 per MW load).
- Creation of more than 400 Customer Equivalent Incapacitating Disturbances (CEID) per 1 MW of customer's load.

The Standards for Degradation of Transmission System *Reliability and Integrity* by Customers applies to future system changes and reconfigurations whether these changes are initiated by the customer or the utility.

The result of the calculations in limits 1, 2 and 3 above will change if the customers load changes.

The result of the calculation for limit 3 is also subject to change if the number of Customer Equivalent Incapacitating Disturbances changes. This could result from a change in the number, size or location of other customers or changes in the utility facilities feeding other customers. A customer may elect to pay for dedicated facilities, with utility approval, to limit the future risk of exposing other customers to Incapacitating Disturbances in limit number 3.

2. Duke ET System Characteristics

All *Project* equipment connected to the *Duke ET System* should be designed to operate within the system conditions defined in this section. These characteristics are typical to the *Duke ET System* during normal and contingency conditions, but may be exceeded for very short times or if exceptional circumstances prevail.

a. Frequency

The frequency of the *Duke ET System* shall be nominally 60 Hz and shall be controlled within the limits of 59.9 Hz - 60.1 Hz unless exceptional circumstances prevail. System frequency could rise to 61 Hz or fall to 59 Hz under exceptional circumstances.

b. Steady-State Voltage Variations

The Duke Electric Transmission System Planning Guidelines for voltage regulation and range at the *Connection Point* are listed in Table 4.

Table 4. System Voltage Variations at the Connection Point

	Absolute	e Voltage	Voltag	e Regulation_
Nominal Voltage (kV)	Minimum	Maximum	Normal	Contingency
44	94 %	109%	8.5%	10%
100	95 %	107%	6%	7%
230	95 %	105%	*	*
500	100 %	110%	*	*

^{*} On 230kV and 500kV, maximum allowable contingency drop is 5%.

c. Harmonic Voltage Distortion

The maximum harmonic voltage distortion at the Connection Point for each transmission voltage level is defined in Table 5.

Table 5. System Harmonic Voltage Distortion Limits

Nominal Voltage (kV)	Maximum Individual Harmonic Voltage Distortion (%)	Maximum Total Voltage Distortion (%)
44	3.0	5.0
100	1.5	2.5
230	1.0	1.5
500	1.0	1.5

The limits in Table 5 represent the maximum harmonic voltage distortion at a given connection voltage for a duration less than or equal to one hour on any single day. The maximum harmonic voltage distortion will not exceed 150% of the limits for a given connection voltage for a duration greater than five minute on any two days during a six month period.

d. Voltage Unbalance

The maximum *Voltage Unbalance* on the *Duke ET System* at the *Connection Point* for a duration greater than or equal to one minute will be less than or equal to 2.0%.

e. Transient Overvoltages

The maximum peak transient overvoltage at the Connection Point will be less than or equal to 200% of the nominal system peak voltage.

f. Temporary Overvoltages

The maximum temporary overvoltage at the *Connection Point* will be less than or equal to 180% of the nominal system voltage. For *Effectively Grounded* portions of the *Duke ET System*, the maximum may be significantly lower than 180%.

E. Protection Requirements

This section establishes the minimum design objectives and recommended design philosophy for the protective systems associated with a load delivery from the *Duke ET System*. A protective system is defined as those components used collectively to detect defective power system elements or conditions of an abnormal or dangerous nature, to initiate the appropriate control circuit action, and to isolate the appropriate system components in order to alleviate or minimize the harmful effect of the abnormality.

In analyzing the relaying practices to meet the broad objectives set forth, consideration must be given to the type of equipment to be protected, e.g., generators, lines, transformers, buses, etc., as well as the importance of the particular equipment to the integrity of the transmission system. Thus, practices may vary for different equipment, and for different applications of the same type of equipment. While it is recognized that the probability of failure should not negate the single contingency principle, the practices adopted may vary, based on judgment and experience as to the development of a workable and practical set of standards. Special local conditions or considerations may necessitate the use of more stringent design criteria and practices.

1. Protective Relaying Philosophy

a. Objectives

The basic design objectives of any protective scheme are to

- Insure safety of the general public
- Maintain dynamic stability;
- Prevent or minimize equipment damage;
- Minimize equipment outage time;
- Minimize the system outage area;
- Minimize system voltage disturbances;
- Allow the continuous flow of power within the ratings of equipment on the system.

b. Protective System Design Considerations

The philosophy in the implementation of any protection system should be to detect and isolate all failed or faulted components as quickly as possible, while minimizing disruption to the remainder of the electric system. This objective implies that a protection system should be: (1) dependable - operate when required, (2) secure - not operate unnecessarily, (3) selective - only the minimum required number of devices should operate, and (4) fast - minimize hazards to personnel and damage to equipment. In addition, backup protection should clear any fault upon failure of the protective equipment in the primary protection system.

c. Operation

Operation of the *Project* should not adversely affect the *Duke ET System*. This includes switching operations as well as faults within the *Project*. The *Project Sponsor* is responsible for providing protection for the *Project* and must demonstrate that their own equipment properly protects all of their facilities. The *Project* should not be designed or operated with a ground source at the connected voltage unless specifically approved by *Duke ET*.

d. Fault Analysis

All operations of protective devices within the *Project* are to be reviewed and documented. This information will be available to *Duke ET* on request to assist in analyzing fault operations on the *Duke ET System*. To facilitate the analysis of system disturbances and the evaluation of system operation, fault recorders may be required on certain types of complex substations and at all large unit generating stations connected to the *Duke ET System*. Fault recording functions in microprocessor relays may provide the detailed data needed to perform the analysis.

e. System modifications beyond the Connection Point

System protection modifications to the *Project* are to be reviewed by *Duke ET* before changes are made. These changes are defined as changes in interrupters, lines, transformers, protective devices and protective settings. This review is needed to insure proper operation of the power systems and coordination of protective devices.

f. Maintenance of Equipment

Project Operator will perform protection equipment maintenance on a regular schedule. This is to include the following:

- Functional testing of trip circuit
- Functional testing of interrupter
- Calibration testing of protective devices settings
- Inspection and maintenance of power dc sources
- Inspection and maintenance of interrupter

2. 100-kV Load Delivery (radial load at Connection Point)

Duke ET will be responsible for providing protection for the Duke ET System.

- Protection beyond the Connection Point is the responsibility of the Project Sponsor and/ or Project Operator and must be coordinated with Duke ET System protective devices.
- The Project Sponsor may be required to provide a Protection Station Immediately beyond the Connection Point to provide protection for the Project.
- Protection will include devices to detect and interrupt all types of faults. This
 generally will include overcurrent protection for both phase and ground faults and
 a three phase interrupting device.
- The overcurrent protection should provide both instantaneous tripping for high value faults and time delay (Inverse) tripping for lower value faults.
- All protective relays will be in service at all times and not be blocked for automatic
 or manual testing of the *Project*. When required for switching, ground relays may
 be blocked.
- One time delayed automatic reclose to the *Project* can be performed. Up to two
 time delayed automatic recloses may be allowed on 44-kV deliveries if fed directly
 from a tie station bus. Reclosing intervals must be coordinated with the *Duke ET*System reclosing devices.
- Manual testing of the Project after a lockout is to be coordinated with Duke's TCC before testing the tine.
- Fault monitoring/location equipment is recommended at Protection Stations.
- Functional testing of protective circuits and interrupting device should be regularly performed.
- All protective device operations at transmission voltages will be analyzed and documented.

3. 100-kV Load Delivery Requiring a New Duke ET -Owned Tap Line

Protection of any *Duke ET* -owned tap line will be reviewed to determine if additional protection is required. If additional protection is required due to the addition of the *Project*, it will be to protect *Duke ET* -owned facilities and the *Project Sponsor* is still required to provide protection as defined in Section 2 (above) for the *Project*. The length and location of the *Duke ET* -owned tap line will determine if *Duke ET System* requires additional protection.

- If Duke ET System's standard protective devices can not detect faults at the end
 of the Duke ET -owned portion of the tap line, additional protection will be
 required. This will either require a protective device and interrupter at the
 transmission line tap or additional protective devices on the transmission line.
- If additional protective devices are needed on the Duke ET System, then zone
 distance pilot relays at each end of the transmission line may be required. Also a
 communication channel between the two ends of the line may be required. This
 scheme may be used to allow the reach of the distance relay to be extended to
 the end of the tap line without causing the transmission line to trip for remote
 faults not on the line.

4. Dual Feeds to Project, 44-kV, 230-kV and Higher, etc.

These will be evaluated as needed. The protection requirements for this type of station vary with the location and type of feeds.

F. Metering and Telecommunication Requirements

All *Projects* that are connected to the *Duke ET System* will require revenue-accuracy-metering equipment (i.e. metering enclosure with meter and associated equipment, instrument transformers, and certain interface enclosures with associated isolation devices). This section states the minimum requirements for metering and telecommunication associated with a load delivery from the *Duke ET System*.

1. Supervisory Control and Data Acquisition (SCADA)

Loads larger than 100 MVA may require *SCADA* depending on their location to ensure that the *TCC* has the information necessary for maintaining system reliability.

The following data may be required:

- Connection Point isolation device(s) status
- Load MW and MVAR measured at the Connection Point
- Voltage at the Connection Point
- MW and MVAR line flow on any transmission line coming into the substation

2. Metering

Metering equipment should be installed, if possible, at the Connection Point. If not installed at the Connection Point then power transformer and/or line losses will need to be considered.

a. Metering Equipment Requirements

A solid state meter shall be used to measure the real and reactive power interchange between the *Duke ET System* and the *Project*. Three-element, three-phase, four-wire meters shall be utilized on wye connected power systems. Two-element, three-phase, three-wire meters shall be utilized on delta connected power systems.

A bl-directional watt/var-hour meter may be necessary if there is power flow in and out of the *Duke ET System*.

For metering equipment located in the *Project* substation, the installation of a metering bypass is suggested, but not required. For the replacement of failed or malfunctioning equipment a metering bypass is necessary to maintain power flow to the *Project*. If a metering bypass is not installed, an outage will be required to replace the failed or malfunctioning equipment.

The metering devices must be fully compatible (approved meter type and communication media) with *Duke ET System's* remote metering and data acquisition system.

b. Meter Accuracy

Meters shall be calibrated to 0.5% accuracy at unity power factor for both full load and light load. These meters shall be calibrated to 1.0% accuracy for 0.5 power factor at full load. Metering accuracy limits are stated in the following table.

METER ACCURACY LIMITS					
Watt-hour Function Var-hour Function					
Full Load	Full Load Power Factor Light Load				
+/- 0.5	+/- 1.0	≠ <i>l</i> - 0.5	+/- 1.0		

Notes:

- Watt-hour and var-hour functions should be tested in both directions of energy flow (in and Out)
- When compensating for transformer or line loss, utilize stated limits above or 5% of desired compensation, whichever is greater.
- The meter shall be tested with compensation applied to obtain a true test of the installation.

Test Points	Volts	Amps	Power Factor
Full Load	120	5	1.0
Power Factor	120	5	0.5
Light Load	120	0,5	1.0

c. Instrument Transformers

Voltage and current transformers shall be 0.3% metering accuracy class for both magnitude and phase angle over the burden range of the installed metering circuit. Instrument transformer correction factors may be applied to the meter to adjust the meter for inaccuracies associated with the secondary burdens in the current transformer and voltage transformer circuits. All instrument transformers shall comply with ANSI/IEEE Stamdard C57.13.

d. Loss Compensation

If the metering is not located at the Connection Point, then power transformer and/or line loss compensation will need to be considered. Duke ET approved power transformer and/or line loss compensation values should be applied to the meter to properly compensate for the losses in the power transformer and/or line.

e. Access to Metering Data

If access to the meter is required, proper security measures must be taken to ensure the integrity of the meter is not compromised. If data pulses are required from the revenue meter, then the appropriate interface box with associated equipment must be installed to properly protect the revenue meter. If an additional information meter is requested, good engineering practices must be adhered to when terminating the connections in the meter circuit to ensure the integrity of the revenue-accuracy metering circuit is intact.

f. Station Service Power

Metering requirements for the *Station Service* Power, if any, will be determined on a case-by-case basis.

g. Calibration of Metering Facilities

Metering facilities shall be tested and calibrated if necessary every two years. More frequent test intervals may be negotiated. All interested parties or their representatives may witness the calibration tests. Calibration records shall be made available to all interested parties. The accuracy of the standard utilized for calibration purposes shall be traceable to the National Institute of Standards and Technology, (NIST).

3. Voice Communication

Requirements, if any, will be determined on a case-by-case basis.

4. Telecommunications for SCADA

Consist of either leased phone lines, microwave channels, or fiber-optics from the site to the *TCC*. Factors involved in selecting a type of circuitry are availability, proximity to the site, and cost. Fiber is preferred. These are dedicated channels and are not redundant.

5. Telecommunications for Revenue-accuracy metering

A compatible and reliable communication media must be provided and maintained, to enable *Duke ET* to interrogate the meter, collect, merge, and store metering and usage data with *Duke ET System*'s remote metering and data acquisition system.

6. Telecommunications for Protection Systems

Most *Projects* connected to the *Duke ET System* will not require any special communication devices/circuits for protection. A local voice/alarm circuit is recommended when an interrupting device is installed.

If the *Project* can back-feed the *Duke ET System* either from a generator or alternate source, then the protection system may require communications with remote ends of Duke's transmission line. These will be evaluated on a case-by-case basis.

IV. FACILITY CONNECTION REQUIREMENTS – GENERATION AND INTERCONNECTION FACILITIES

A. Scope

The technical requirements contained herein generally apply to all generation facilities and *Interconnections* to the *Duke ET System*. The location of the connection and the impacts on the *Duke ET System*, or another utility's system, determine the specific requirements. The *Project* must not degrade the safe operation, integrity, or reliability of the *Duke ET System*.

Applicable Codes, Standards, Criteria and Regulations

To the extent that the Codes, Standards, Criteria and Regulations are applicable, the *Project* shall be in compliance with those listed in the References section of this document and others that are applicable.

Safety, Protection, and Reliability

Duke ET, after consultation with the *Project Sponsor* and other relevant parties, shall make the sole and final determination as to whether the *Duke ET System* is properly protected from any problems that the *Project* might cause before a connection is closed. The *Project Sponsor* is responsible for correcting such problems before connected operation begins. The *Project Sponsor* is responsible for safety, protection, and reliability on the *Project* side of the *Connection Point*.

Non-Duke Responsibilities

Project Sponsors and Project Operators shall comply with NERC Planning Standards and Operating Policies. The Project Sponsor is responsible for the planning, design, construction, reliability, protection, and safe operation of non-Duke-owned facilities. The design and operation of the Project is subject to applicable local, state and federal statutes and regulations.

• Cost of Connection Reviews

The *Project Sponsor* requesting *Duke ET* to perform a *Connection Review* will reimburse *Duke ET* for its actual costs to perform the study. This includes costs associated with verifying that all technical requirements in this document are properly addressed.

B. Request for Generation and Interconnection Studies

Project Sponsors should contact Duke Electric Transmission as early as possible in the planning process for any potential new/modified utility Interconnection or generation connection to the Duke ET System. The Project Sponsor should supply information about the location, voltage, and other pertinent connection requirements. Certain areas within the Duke ET System can accept only limited amounts of additional generation without costly reinforcements. Duke ET may have to add to or modify its transmission system substantially before connecting a new Project. A Connection Review must be performed to determine the required connection facilities and modifications to accommodate the Project. This study may also address the transmission system capability, transient stability, voltage stability, losses, voltage regulation, harmonics, voltage flicker, electromagnetic transients, ferroresonance, metering requirements, protective relaying, substation grounding, and fault duties. If necessary, joint study with neighboring control areas may be performed to assess the impact of the Project. The data that the Project Sponsor is required to provide to enable the completion of these studies is listed in the Project Sponsor Supplied information section.

Proposals for Interconnection with other control areas will require a Connection Review. The new Interconnection would require development of a new, or modification of an existing interchange or Interconnection agreement. In addition to the technical aspects of the new Interconnection, a business case would have to be developed to examine the economics of the proposal.

1. Connection Configuration

Projects may be connected to the Duke ET System by tapping an existing transmission line(s) or by connecting directly into an existing transmission station. A new transmission switching station may be built in the middle of an existing transmission line. Duke's 500-kV and 230-kV transmission systems are typically reserved for the bulk transport of large amounts of electricity.

The number of available connection options is dependent upon many factors, including location of the desired *Connection Point* relative to existing Duke transmission facilities, the size of the *Project's* generation, present transmission line loading, and other requirements of the *Project*. The most feasible option(s) will be considered in the *Connection Review*, with the most economic option meeting all requirements being selected.

2. Power Flow

The *Project* is incorporated into power flow models by *Duke ET* using the data provided by the *Project Sponsor*. Power flow simulations are performed to determine the impact of the *Project* on the transmission system. The *Project Sponsor* must provide the expected source and sink of energy related to the *Project*. The primary intent is to determine if the *Project* causes any violations of the Duke Electric Transmission Planning Guidelines (Planning Guidelines), which is part of Duke's annual FERC 715 filing, the *SERC* Planning Principles and Guides, or the *NERC Planning Standards* (collectively, *Planning Standards*). A summary of these guidelines is provided below:

a. Thermal and Voltage Screening

The purpose of this study is to ensure that the connection of the *Project* does not create any thermal loading or voltage levels outside of the limits provided in the Planning Guidelines. *Project* information obtained from the *Project Sponsor* is used to model the *Project*. Power system simulation tools are used to model a

wide range of transmission system operating conditions to determine the thermal loading and voltage level changes created by the *Project* on the *Duke ET System*.

b. Transfer Capability

The purpose of this study is to ensure that the connection of the *Project* does not reduce the ability of the transmission system to transport power over long distances between and among control areas. Joint studies with other utilities may be necessary. Transfer Capability requirements are detailed in the *Planning Standards*. Power transfers are simulated across the *Duke Electric Transmission System* in various directions to determine how the *Project* affects Duke's ability to transfer power across its system and to and from other control areas.

c. Fault Duty

The purpose of this study is to determine the changes in available fault duty caused by the *Project*. Transformer, line and generator impedances, and the circuit configuration are needed to create the model for the study. The data is inserted into the current *Duke ET* model. The new generation buses and those local to it are faulted to allow comparison with fault conditions prior to the addition of the *Project*. The study results are reviewed to ensure that no equipment ratings will be exceeded and are utilized for determining the type of grounds used for personnel protection for conducting de-energized line and station work.

d. Stability

Dynamics software is used to evaluate the impact of the new system configuration and additional generating capacity on system stability. In addition to the normal steady state model data, generator impedances and time constants, turbine governor data, and voltage regulator data are needed to create a model for the study. The new generation buses and those local to it are faulted to evaluate system stability with and without the *Project*. Study results are evaluated to ensure system stability will be maintained and that any necessary changes to relaying or controls are identified. See the General Requirements section for more detail on generator controls.

3. Protection

After studying the possible ways to connect the *Project* to the *Duke ET System*, the protective requirements will be determined. This will include an impedance model at the *Connection Point* (short-circuit data), protective changes to the transmission system, protective requirements for the generation and any special protective needs for the *Project*. See the General Requirements and Protection Requirements sections for more details on these requirements.

4. Power Quality and Reliability

There is a very diverse set of users connected to the *Duke ET System* with differing system requirements. In the past, most customers were only concerned with extended interruptions. However, the increased use of highly sensitive power electronic devices within all customer sectors has changed the definition of reliability. Due to the sensitivity of many industrial and commercial loads such as adjustable speed drives (ASDs) and computer controlled processes, reliability is no longer only defined by the frequency and

duration of sustained interruptions. There are many power quality variations other than sustained interruptions than may constitute inadequate service for the proper operation of customer equipment. Variations such as *Voltage Unbalance*, voltage flicker, harmonic distortion, transient overvoltages, temporary overvoltages and steady-state voltage regulation can adversely affect customer processes.

The challenge for the transmission owner is to design and operate the transmission system such that it meets the requirements of this diverse set of users. To meet this challenge, Duke Electric Transmission performs studies to determine the power quality and reliability impacts of any new *Project* on the *Duke ET System* at the *Connection Point*. The intent of these studies is to ensure that the connection of the *Project* does not compromise the reliability and integrity of the *Duke ET System*.

The studies performed for each new Project may include:

a. Voltage Unbalance

The purpose of this study is to ensure that the operation of any new *Project* does not create a *Voltage Unbalance* condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of *Voltage Unbalance* created by the *Project* at the *Connection Point*.

b. Voltage Flicker

The purpose of this study is to ensure that the operation of any new *Project* does not create voltage fluctuations in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of voltage fluctuations created by the *Project* at the *Connection Point*.

c. Harmonic Distortion

The purpose of this study is to ensure that the operation of any new *Project* does not create harmonic current injections in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of harmonic distortion created by the *Project* at the *Connection Point*.

d. Transient Overvoltage

The purpose of this study is to ensure that the operation of any new *Project* does not create a transient overvoltage condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of translent overvoltages created by the *Project* at the *Connection Point*.

e. Temporary Overvoltage

The purpose of this study is to ensure that the operation of any new *Project* does not create a temporary overvoltage condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of temporary overvoltages created by the *Project* at the *Connection Point*.

f. Temporary Undervoltage

The purpose of this study is to ensure that the operation of any new *Project* does not create a temporary undervoltage condition in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* is added to the power system model. Using power system simulation tools, studies are performed over a wide range of transmission system operating conditions to determine the range of temporary undervoltages created by the *Project* at the *Connection Point*.

g. Insulation Coordination

The purpose of this study is to ensure that the operation of any new *Project* does not create a condition that will require intervention of Duke-owned transmission equipment in excess of the limits provided in the Performance Requirements section. *Project* information obtained from the *Project Sponsor* regarding insulation coordination studies is reviewed and must be approved by *Duke ET* prior to connection. *Duke ET* may perform independent studies verifying the models and assumptions used by the *Project Sponsor* are appropriate for their application.

5. Changes to Project Sponsor-Supplied Information

If any data previously supplied pursuant to these connection requirements changes, the *Project Sponsors* or *Project Operator* will notify *Duke ET* in writing without delay. Data changes may require additional studies to examine the impact. This notification will include:

- the time and date at which the change became, or is expected to become, effective
- if the change is only temporary, an estimate of the time and date at which the data will revert to the previously supplied form.

A request for a change in *Connection Point* to the *Duke ET System*, level of generation, or expected sink must be submitted as a new request. A new completion date will be negotiated with the *Project Sponsor* or *Project Operator* when *Project* data is changed.

6. Required Project Sponsor-Supplied Information

Any *Project Sponsor* desiring a new connection or modification of an existing connection must provide the following applicable information:

- Company name and contact name
- 2. Address

- 3. Phone number, fax number, e-mail address of contact name
- 4. Effective date of new connection or modification
- Proposed geographic location and Plot Plan providing orientation of the Project on the Site (USGS map)
- 6. Electrical Connection Point
- 7. Voltage level of Proposed Connection
- 8. One-line diagram of Project
- 9. Start-up Date
- 10. Commercial Operation Date
- 11. Contract Path & Source and Sink for the energy
- 12. Duration of Contract
- 13. Expansion Plans
- 14. Number and Type of Units
- 15. Plant Start-up Load
- 16. Fuel Type
- 17. Total Generation Capability (MW) Summer and Winter ratings
- 18. Power Factor
- 19. Generator Data (for each generator)
 - A. Manufacturer
 - B. Base MVA
 - C. Maximum MVA
 - D. Rated MW (Summer & Winter)
 - E. Rated kV
 - F. Rated Power Factor
 - G. % Reactance Synchronous, Sub-Transient & Translent
 - H. Capability Curve Data
 - I. Auxiliary Load Data
 - J. Dynamic Modeling Data H, Ra, Xd, Xq, X'd, X'q, X"d, X"q, XI, T'do, T'qo, T"do, T"qo, S(1.0), S(1.2)
 - K. Governor & Excitation System Models IEEE or PTI format
- 20. Step-up Transformer Data
 - A. Manufacturer
 - B. Connection (Delta/Wye)
 - C. KVA ratings of all windings
 - D. H winding kV
 - E. X winding kV
 - F. Y winding kV
 - G. Transformer neutral load (If wye connected on the high side) in ohms
 - H. Impedance (%Z) and load losses (W) @kVA for all tap combinations of H-X, H-Y, & X-Y
 - I. No load losses and magnetizing current
- 21. Other transformer ratings, connections, voltage taps, impedances, and grounding
- 22. Transmission line voltage, conductor rating, impedance, length
- 23. Lightning protection designs for transmission lines and stations
- 24. Special requirements (e.g. sensitive equipment, dual feeds, etc.)
- 25. Preferred method of connection (ring bus, breaker and a half, etc.)
- 26. Relay schemes, relay settings, protection equipment
- 27. Maintenance schedules and procedures

C. General Requirements

1. Safety

All safety and operating procedures for joint use equipment shall be in compliance with the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.269, the National Electrical Safety Code (NESC), the <u>Duke Power Safe Work Practices</u>

Manual, the <u>Duke Electric Transmission Operating Procedures Manual</u> and the *Project Sponsor's* safety manuals.

a. Isolation Requirements

The *Project Operator* shall not energize any *Duke ET System* line or equipment unless the Duke *TCC* specifically approves energization. If, for any reason, a protective device operation separates the *Project* from the *Duke ET System*, the *Project Operator* will contact the Duke *TCC* before attempting to restore the connection to the *Duke ET System*.

At the Connection Point with the Duke ET System, a disconnect switch shall be provided for the purpose of physically and visibly isolating the Project from the Duke ET System. With the consent of Duke ET and the Project Sponsor, the disconnect switch may be installed at another location, other than the Connection Point, provided that the purpose described herein is satisfied. The device:

- Must be accessible by Duke ET and under Duke TCC jurisdiction.
- If gang-operated, must be lockable in the open position by Duke ET.
- Must be suitable for safe operation under the conditions of use.
- Would not be operated without advance notice to either party, unless an emergency condition requires that the device be opened to isolate the Project.

Duke ET personnel may open the switch:

- If it is necessary for the protection of Duke ET maintenance crew personnel when working on de-energized circuits.
- If the Project or Duke ET System equipment presents a hazardous condition.

Consideration shall be given as to the design and capacity of the switch on a case-by-case basis. The switch is required for safety and may not be required to interrupt load or energization (charging) current. However, a suitable switch for the safety requirements herein described may also be used to provide for other operational purposes.

b. Cogeneration Served by the Project

The *Project Sponsor* shall maintain a record of all cogeneration customers served by the *Project* and such record shall be made available to *Duke ET*. For the requirements of energized line maintenance or line construction on the *Duke ET System*, the *Project Sponsor* will ensure that all cogeneration customers served by the *Project* will disconnect their generation upon request by *Duke ET*.

2. Connection Point Considerations

a. General Configurations and Constraints

Integration of *Projects* into power systems usually falls into one of the following three categories:

- Connection into an existing 44-kV to 500-kV substation.
- Connection on the low-voltage side (typically 4-kV to 24-kV) of a new or existing customer service transformer that was originally designed to serve load. Load Delivery Requirements apply to projects having generating capability of less than 25% of minimum load.
- Connection at 44-kV to 500-kV to a transmission line by building a new switching station in the vicinity of the *Project*.

b. Other Considerations

Below are some of the other issues considered when evaluating *Project* proposals:

1) Equipment

Existing electrical equipment, such as transformers, power circuit breakers, disconnect switches, and line conductors were purchased based on the duties and capacity limits expected in response to system additions identified in long-range plans. However, with the connection of a new generating resource or large loads, some equipment may become overloaded and need to be replaced.

2) Outage Coordination & Maintenance

Duke ET operates and maintains its system to provide reliable customer service at all times. Project integration requires that the equipment at the Point of Connection not restrict timely outage coordination, automatic switching or equipment maintenance scheduling. Preserving reliable service to all Duke ET customers is essential and may require additional switchgear, equipment redundancy, or bypass capabilities at the Point of Connection for acceptable operation of the system.

3) Atmospheric & Seismic

The effects resulting from wind storms, floods, lightning, altitude, temperature extremes, and earthquakes must be considered in the design and operation of the *Project*. The *Project Sponsor* is responsible for determining that the appropriate standards are met, including, but not limited to, the Uniform Building Code (UBC) and the National Electrical Safety Code (NESC). Depending on *Project* location, size, type, and importance, Duke Energy may request that additional capabilities be designed into the *Project*.

3. Substation Grounding

Each generation site and/or interconnecting substation must have a ground grid that solidly grounds all metallic structures and other non-energized metallic equipment. This grid shall limit the ground potential gradients to such voltage and current levels that will not endanger the safety of people or damage equipment which are in, or immediately adjacent to, the station under normal and fault conditions.

If the Project is physically close to another substation, it is recommended that the two ground grids be connected. The interconnecting cables must have sufficient capacity to handle fault currents and control ground grid voltage rises. Duke ET must approve any connection to a Duke substation ground grid. If the ground grids must be isolated for operational reasons, there must be no metallic ground connections between the two substation ground grids. Cable shields, cable sheaths, station service ground sheaths, and overhead transmission shield wires can all inadvertently connect ground grids. Fiberoptic cables are an excellent choice for telecommunications and control between two substations to maintain isolated ground grids. In the case where the *Project* is physically close to another substation but the ground grids are isolated, the Project Sponsor must demonstrate that the ground grids are properly isolated and in compliance with all applicable codes and standards. Duke ET prefers to connect static wires on incoming transmission lines to the station ground grid. If the Project Sponsor prefers not to connect static wires on incoming transmission lines to the station ground grid; the Project Sponsor must notify Duke ET in writing and demonstrate that relay performance, lightning protection, and personnel safety are not compromised by isolating the static wires from the station ground grid.

The *Project* ground grid should be designed to ANSI/IEEE Std, 80-1986, IEEE Guide for Safety in AC Substation Grounding, and should be measured in accordance with IEEE - 81 Part 1: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Potentials and Part 2: Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems. Project grounding requirements shall also comply with the National Electrical Safety Code, ANSI/IEEE - 665 Guide for Generating Station Grounding, IEEE - 837 Standard for Qualifying Permanent Connections Used in Substation Grounding, IEEE - 487 Protection of Wire-Line Communication Serving Electric Power Stations, ANSI/IEEE 367-1987 IEEE Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault, and any applicable state and local codes.

4. Insulation Coordination

Power system equipment is designed to withstand voltage stresses associated with expected operation. Connection Studies include the evaluation of the impact of the *Project* on equipment insulation coordination. *Duke ET* identifies additions required to maintain an acceptable level of *Duke ET System* availability, reliability, equipment insulation margins, and safety.

Voltage stresses such as lightning surges, switching surges, temporary overvoltages, and normal 60Hz voltages may affect equipment duty. Remedies depend on the equipment capability and the type and magnitude of the stress. Below are the requirements that must be met to connect to the *Duke ET System*. In general, stations shall be protected against lightning and switching surges. Typically this includes station shielding against direct lightning strokes, surge arresters on all wound devices, and shielding on the incoming lines.

a. Lightning Surges

Lightning is the single largest cause of transmission line events in the *Duke ET System* service area and must be considered during the design and installations of transmission lines and substations. Lightning related causes are not exempt from the Performance Requirements section. Although it is not always cost effective to design and build a power system to withstand every possible lightning stroke, it has been demonstrated that with proper design and installation procedures, the effects of lightning can be mitigated to achieve a reliability level equal to or exceeding the requirements of the *Project* performance criteria section. Techniques used to help control lightning related events on transmission lines include proper use of shield wires, insulation levels, low resistance grounding, and surge arresters. Techniques used to help control lightning related outages in substations include substation shielding, proper arrester applications, and shielding of incoming transmission lines.

If the *Project* proposes to tap a Duke transmission line that Is shielded, the new tap line must also be properly shielded for at least one mile from the *Duke ET System*. If any stations are within one mile of the *Duke ET System*, these also must be properly shielded from direct lightning strokes. The *Project Sponsor* must be able to demonstrate proposed designs for any transmission lines and substations will perform within the limits for service interruptions as stated in the Performance Requirements section.

For transmission line design, an industry recognized lightning performance estimating algorithm may be used to demonstrate acceptable performance of the design. The *Project Sponsor* must make reasonable assumptions based on the area that the transmission line will be installed including ground flash density and grounding conditions. The *Project Sponsor* must be able to provide an alternative plan if the ground conditions required for acceptable performance are not achieved during construction of the transmission line.

For substation design, the *Project Sponsor* must be able to demonstrate their proposed designs will operate within the performance requirements. The shielding designs and arrester applications shall adhere to applicable IEEE standards. In addition, any normally open points that are subject to voltage "doubling" of incoming lightning surges must be considered and protected accordingly so the Performance Requirements are not violated.

b. Switching Surges

At voltages below 500-kV, modifications to protect the *Duke ET System* against *Project*-generated switching surges are not anticipated although the *Connection Review* identifies the actual needs. At 500-kV, *Duke ET* may require that arresters be added at the line terminations of the substations if switching surge studies predict overvoltages that may otherwise cause a flashover at the *Project's* facilities.

c. Temporary Overvoltages

Temporary overvoltages can last from seconds to minutes, and are not characterized as surges. These overvoltages are usually present during faults and other abnormal system conditions. The *Duke ET System* is typically considered *Effectively Grounded* at 100-kV and higher voltages. However, the 44-kV system is not *Effectively Grounded* in all locations. These systems may be

impedance grounded and can have line to ground voltages approaching 1,73 times normal line to ground voltage during fault conditions on unfaulted phases. It is not acceptable for the *Project* to supply any ground source for the transmission system unless specifically approved and coordinated with *Duke ET*.

When generation is connected to the low-voltage side of a delta-grounded wye (D-YG) transformer, remote end breaker operations initiated by the detection of faults on the high-voltage side can cause overvoltages that can affect personnel safety and damage equipment. In these instances, *Duke ET* will require the *Project* to rapidly separate the generator from the step-up transformer by tripping a breaker using either remote relay detection with pilot scheme (transfer trip) or local relay detection of overvoltage condition.

A system study may be performed for each *Project* based on the point on the *Duke ET System* that is being connected. The *Project Sponsor* will be supplied the system characteristics needed to calculate the temporary overvoltages that need to be considered. Gapless metal-oxide surge arresters are especially sensitive to system temporary overvoltages and *Duke ET* may review the specification of arresters used on 44-kV systems to ensure proper application.

d. Normal Operating Voltages

The *Duke ET System* voltages are normally operated within the limits specified in the Performance Requirements section of this document. Insulation Coordination usually does not need to consider this operating range once lightning and switching surge requirements are met; however, in highly contaminated areas, special consideration and additional insulation requirements may be required for proper insulation coordination. The *Project Sponsor* is responsible for determining whether special insulation requirements are needed for its system.

5. Inspection, Testing, Calibration and Maintenance

The *Project Sponsor* and *Project Operator* have full responsibility for the inspection testing, calibration and maintenance of its equipment, up to the *Connection Point*, consistent with the power purchase, operating agreement or interconnection agreement. Maintenance activities must be coordinated with the *Project* and *TCC* and/or *SOC* to ensure the *Duke ET System* is not adversely affected.

a. Preenergization Inspection and Testing

Before initial *Project* energization, the *Project Sponsor* or *Project Operator* shall develop an Inspection and Test Plan for preenergization and energization testing. This plan should include provisions for testing protective equipment that comply with the *NERC Planning Standards*, Section III A, Guide G9. *Duke ET* will review and must approve the test plan prior to the test. *Duke ET* may require additional tests; the costs of these tests are subject to negotiation. The Sponsor shall make available to *Duke ET* all drawings, specifications, and test records of the *Project* equipment pertinent to interconnected operation.

b. Calibration and Maintenance

1) Revenue Metering

Revenue metering shall be tested and calibrated if necessary at least every two years. More frequent test intervals may be negotiated. All interested parties or their representatives may witness the calibration tests. Calibration records shall be made available to all interested parties. The Metering and Telecommunication Requirements section should be reviewed for further details.

2) All other equipment

The Project Sponsor or Project Operator shall implement a preventive maintenance program for the Project equipment. The program shall be designed and executed in a manner to ensure the proper operation of the Project equipment. The program may be based on time or on other factors, including performance levels or reliability. Appropriate equipment performance data will be collected and maintained by the Project Sponsor or Project Operator. Duke ET reserves the right to review the Project's preventive maintenance program. Maintenance records of the Project equipment pertinent to interconnected operation shall be made available to Duke ET upon request.

6. Station Service

Power provided for local use at a substation to operate lighting, heat and auxiliary equipment is termed *Station Service*.

Alternate Station Service is a backup source of power, used only in emergency situations or during maintenance when primary Station Service is not available usually only in large switching stations.

Appropriate providers of *Station Service* and alternate *Station Service* are determined during the *Project* planning process, including *Project* diagram development and review. Generally, the utility with a distribution service will be the preference provider of primary *Station Service* unless 1) it is unable to serve the load, or 2) costs to connect the local utility are prohibitive.

The *Project Sponsor* must provide metering for *Station Service* and alternate *Station Service*, as specified by the metering section of this document.

7. Isolating, Synchronizing and Black Starts

a. Isolation

The *Project Sponsor* is responsible for ensuring that proper current-interrupting, isolating equipment is acquired and installed at the facility. This equipment will be installed for the purposes of protecting the *Project* from faults or other undesirable conditions on the transmission system, and to protect the transmission system from faults internal to the *Project*.

During emergency conditions, the *Project Operator's* first duty is to ensure safety guidelines are achieved and to protect station

equipment. The *Project Operator* should have a Duke approved set of procedures on file at the Duke System Operating Center (SOC) and at the *Project* that are to be followed when separating from and reconnecting to the transmission system. These procedures, jointly developed by the *Project Operator* and *Duke ET*, typically include: 1) a frequency limit duration table, 2) a circuit breaker operation procedure, 3) a generator loading/circuit protection procedure, and 4) a set of unit operating conditions that should be maintained to prevent damage to the unit(s) and/or the transmission system.

The *Project Operator* should NOT energize any equipment, connect to any energized equipment unless instructed to do so by the Duke *TCC*, or parallel any generation to the system unless instructed to do so by the Duke *SOC* System Coordinator. If, for any reason, the *Duke Electric Transmission System* is disconnected from the *Project* (through a fault condition, line switching, etc.), the protective equipment connecting the *Project* to the system must open and not reclose until approved by the *TCC*.

b. Synchronization

The *Project Operator* shall be responsible for synchronizing its equipment to the *Duke ET System*. If the *Project* is a participant in the Duke Emergency Guidelines for Capacity Shortages, then the *Project Operator* should follow those procedures during the event of a system emergency. During all other conditions, the generator should have *Duke ET* approved procedures in place when connecting to the system. For automatic synchronization, a synchronizing relay shall be installed to assure that the unit is not connected to the energized power system out of synchronization.

c. Blackstart

Blackstart is the condition when a unit of a generation *Project* starts up under local power, in isolation from the *Duke ET System*. Blackstart capability is needed in the rare event of a system restoration emergency. Depending on the size and location of a *Project*, this service may be needed from that *Project*. It is generally not needed for small generators or for *Projects* in close proximity to other major generation. If the *Project* is supplying blackstart capability to the *Duke ET System*, then it will be a participant in the Duke Emergency Guidelines for Capacity Shortages. In the event of a local or wide-spread blackout, those guidelines should be followed to ald in the restoration of the system. If for any event, generation is not running and the *Project* becomes completely deenergized, the *Project Operator* should advise the Duke System *SOC* Coordinator of its status and await further Coordinator instruction.

Some issues *Duke ET* considers when determining whether to request the capability of a *Project* to provide blackstart capability include the following:

- Proximity to other generation (i.e. Can blackstart capability be provided more efficiently from another Project?)
- Location of the Project on the transmission system (i.e. Is the Project near major load centers and far from other generation?)
- Cost of on-site start-up; and
- Periodic testing to ensure personnel training and capability.

D. Performance Requirements

All *Projects* must be properly designed, constructed, operated, and maintained to avoid degrading the reliability of the transmission network. A *Project* must comply with the *Project* performance criteria, listed below, and must be able to operate satisfactorily within the limits defined in the Duke ET System Characteristics section, below, in order to be considered properly connected. The *Project Sponsor* or *Project Operator* is expected to demonstrate, through monitoring, that the *Project* meets the performance criteria. It is required that the criteria of Sections 1.a and 1.b be continuously monitored. The remaining criteria must be met and considered in the design and operation of the *Project* although these do not necessarily have to be continuously monitored. However, if problems are suspected at any time, *Duke ET* may require the *Project Sponsor* and/or *Project Operator* to demonstrate through monitoring the performance of the *Project* at the *Connection Point* meets these requirements.

If the requirements are not met, the *Project Sponsor* or *Project Operator* must demonstrate to *Duke ET* a plan to improve and meet the performance criteria. Additional relay and control requirements may be developed and enforced by *Duke ET* after connection is made if these performance criteria are violated. Enforcement of these performance criteria and penalties associated with them are beyond the scope of this document and will be in *Project*-specific contracts and operating agreements.

1. Project Performance Criteria

To ensure the reliability and integrity of the supply system, all *Projects* must meet the *Project* performance criteria at the *Connection Point*. The following section details the *Project* performance criteria.

a. Transmission System Outages

The *Project* may not operate its equipment or system in such a manner as to cause the unplanned outage of any *Duke ET System* components more than once in any twelve month period, more than three times in any five year period, or more than five times in any ten year period. An unplanned outage is defined as the electrical isolation of equipment from the electrical system, without scheduling and notification of *Duke ET*, such that the equipment is unable to perform its intended function for the duration of the isolation.

b. Temporary Undervoltages

The *Project* may not operate its equipment or system in such a manner as to cause temporary undervoltages at the *Connection Point* more than twice in any twelve month period, more than five times in any five year period, or more than eight times in any ten year period. A temporary undervoltage is defined as an oscillatory phase-to-ground or phase-to-phase voltage of 85% or less of nominal voltage lasting greater than 20 milliseconds, occurring during fault conditions. Undervoltages due to non-fault events are covered in the In the Voltage Fluctuations and Flicker requirements. Multiple temporary undervoltage conditions occurring within one minute will be considered the same event.

c. Transient Overvoltages

The *Project* may not operate its equipment or system in such a manner as to cause a peak transient voltage at the *Connection Point* greater than or equal to 140% of the nominal peak voltage. A transient overvoltage is defined as the peak

line-to-line or line-to-ground voltage during the transient conditions resulting from operation of a switching device. Any transient voltage condition caused by the operation of the *Project's* equipment or system that results in a peak transient voltage greater than or equal to 140% of the nominal peak voltage at the *Connection Point* is not allowed.

d. Temporary Overvoltages

The *Project* may not operate its equipment or system in such a manner as to cause a temporary overvoltage at the *Connection Point* greater than or equal to 120% of the nominal system voltage. A temporary overvoltage is defined as an oscillatory phase-to-ground or phase-to-phase overvoltage lasting greater than 20 milliseconds which is undamped or only weakly damped. Any temporary voltage condition caused by the operation of the *Project's* equipment or system that results in a temporary overvoltage greater than or equal to 120% of the nominal system voltage at the *Connection Point* is not allowed.

e. Voltage Fluctuations and Flicker

Per IEEE Standard 1453-2004, planning levels of P_{si} =0.8 and P_{li} =0.6 define the allowable voltage fluctuation limits at the *Connection Point*. In unique cases, higher limits can be considered with the understanding that the customer operating the disturbing *Project* will be required to mitigate the flicker that they cause, if significant customer complaints are generated. Additionally, any single customer that creates disturbances for other customers will be required to mitigate the disturbance, regardless of the actual measured value.

Operation of the *Project's* system or equipment in such a manner as to create a voltage fluctuation greater than 3% on the transmission system or on the primary of the distribution system is not allowed.

f. Harmonic Content/Harmonic Distortion

The maximum allowable harmonic current injections (percentage harmonic distortion at each frequency as a function of load current) at the *Connection Point* for *Projects* connected at 230-kV or 500-kV, 100-kV, and 44-kV are defined in Table 1, Table 2, and Table 3, respectively. Operation of the *Project's* system or equipment in such a manner as to create a condition where the harmonic current injection at the *Connection Point* exceeds the limits provided for in Tables 1, 2, and 3 for a duration greater than or equal to one hour on any single day or exceeds 150% of the limits provided for the given connection voltage for a duration greater than five minutes on any two days during a six month period is not allowed.

Table 1. Current Injection Harmonic Distortion Limits:
Connection Point Voltage >161000 V

Individual Harmonic Order (Odd Harmonics)						
Iso/Iload	h<11	11≤h<17	17≤h<23	23≤h<35	h>35	TDD
<50	2.0 %	1.0 %	0.75 %	0.3 %	0.15 %	2.5 %
≥50	3.0 %	1.5 %	1,15 %	0.45 %	0.22 %	3.75 %

Notes: Even harmonics are limited to 25% of the odd harmonic limits above

Current distortions that result in DC offset are not allowed

 \mathbf{I}_{load} is the maximum load current (fundamental frequency component) at the Connection Point

Isc is the maximum short-circuit current at the Connection Point

TDD (Total Demand Distortion) is the total harmonic current distortion expressed in % of maximum demand load current

Table 2. Current Injection Harmonic Distortion Limits: Connection Point Voltage 69001 V to 161000 V

Individual Harmonic Order (Odd Harmonics)						
Isolload	h<11	11≤h<17	17≤h<23	23⊴1<35	h≥35	TDD
<20	2.0 %	1.0 %	0.75 %	0.3 %	0.15 %	2.5 %
20<50	3.5 %	1.75 %	1.25 %	0.5 %	0.25 %	4.0 %
50<100	5.0 %	2.25 %	2.0 %	0,75 %	0.35 %	6.0 %
100<1000	6.0 %	2.75 %	2.5 %	1.0 %	. 0.5 %	7.5 %
>1000	7,5 %	3.5 %	3.0 %	1,25 %	0.7 %	10.0 %

Table 3. Current Injection Harmonic Distortion Limits:
Connection Point Voltage 120 V to 69000 V

Individual Harmonic Order (Odd Harmonics)						
Isc/load	h<11	11⊴1<17	17≤h<23	23≤h<35	h≥35	TDD
<20	4.0 %	2.0 %	1.5 %	0.6 %	0.3 %	5.0 %
20<50	7.0 %	3.5 %	2.5 %	1.0 %	0.5 %	8.0 %
50<100	10.0 %	4.5 %	4.0 %	1.5 %	0.7 %	12.0 %
100<1000	12.0 %	5.5 %	5.0 %	2.0 %	1.0 %	15,0 %
>1000	15.0 %	7.0 %	6.0 %	2.5 %	1.4 %	20.0 %

g. Phase Unbalance

Unbalanced phase voltages and currents can affect protective relay coordination and cause high neutral currents and thermal overloading of transformers. To maintain the reliability and integrity of the *Duke ET System*, the *Project* shall not operate its system or equipment in such a manner as to cause a *Voltage Unbalance* greater than 1% nor a current unbalance greater than 5% at the *Connection Point*. Any unbalance condition in excess of the specified limits for a duration greater than or equal to one minute is not allowed. Phase unbalance is defined as the percent deviation of one phase from the average of all three phases

2. Duke ET System Characteristics

All *Project* equipment connected to the *Duke ET System* should be designed to operate within the system conditions defined in this section. These characteristics are typical to the *Duke ET System* during normal and contingency conditions, but may be exceeded for very short times or if exceptional circumstances prevail.

a. Frequency

The frequency of the *Duke ET System* shall be nominally 60 Hz and shall be controlled within the limits of 59.9 Hz - 60.1 Hz unless exceptional circumstances prevail. System frequency could rise to 61 Hz or fall to 59 Hz under exceptional circumstances.

b. Steady-State Voltage Variations

The transmission system planning guidelines for voltage regulation and range at the *Connection Point* is listed in Table 4.

Table 4. System Voltage Variations at the Connection Point

	Absolut	e Voltage	Voltage Regulation	
Nominal Voltage (kV)	Minimum	Maximum	Normal	Contingency
44	94 %	109%	8.5%	10%
100	95 %	107%	6%	7%
230	95 %	105%	*	*
500	100 %	110%	*	*

^{*} On 230kV and 500kV, maximum allowable contingency drop is 5%.

c. Harmonic Voltage Distortion

The maximum harmonic voltage distortion at the *Connection Point* for each transmission voltage level is defined in Table 5.

Table 5. System Harmonic Voltage Distortion Limits

Nominal Voltage (kV)	Maximum Individual Harmonic Voltage Distortion (%)	Maximum Total Voltage Distortion (%)
44	3.0	5.0
100	1,5	2.5
230	1.0	1.5
500	1.0	1,5

The limits in Table 5 represent the maximum harmonic voltage distortion at a given connection voltage for a duration less than or equal to one hour on any single day. The maximum harmonic voltage distortion will not exceed 150% of the limits for a given connection voltage for a duration greater than five minute on any two days during a six month period.

d. Voltage Unbalance

The maximum Voltage Unbalance on the Duke ET System at the Connection Point for a duration greater than or equal to one minute will be less than or equal to 2.0%.

e. Transient Overvoltages

The maximum peak transient overvoltage at the Connection Point will be less than or equal to 200% of the nominal system peak voltage.

f. Temporary Overvoltages

The maximum temporary overvoltage at the Connection Point will be less than or equal to 180% of the nominal system voltage. For Effectively Grounded portions of the Duke ET System, the maximum may be significantly lower than 180%.

3. Switchgear

a. All Voltage Levels

Duke ET's facilities ratings methodology was submitted to SERC in February 1999 for NERC Planning Standards compliance. Circuit breakers, disconnect switches, and all other current carrying equipment connected to Duke's transmission facilities shall be capable of carrying normal and emergency load currents, as defined in the SERC submittal, without damage. For Interconnections, the equipment shall not become a limiting factor (bottleneck) in the ability to transfer power on the Duke ET System.

All circuit breakers and other fault-interrupting devices shall be capable of safely interrupting fault currents for any fault that they may be required to interrupt. Application shall be in accordance with ANSI/IEEE C37 Standards. These requirements apply to the generation site, the interconnecting substation, the Connection Point as well as other locations on the Duke ET System. Minimum fault-interrupting requirements are supplied by Duke ET as part of the coordinating study, and are based on the greater of the fault duties at the time of the connection request or those projected in long-range plans.

b. Circuit Breaker Operating Times

Table 6 specifies the component operating times typically required of circuit breakers on the *Duke ET System*. These times also apply to equipment at the generation site and the *Connection Point*. System stability considerations may require very fast opening and reclosing times. The total automatic recloser times would be the the summation of the breaker interrupt and close time plus intentionally added delay to allow for deionization and subsequent extinction of the fault arc (referred to as the dead timer delay), and the protective relay requirements. The following table shows Duke's required interrupting time of the breaker and the dead "timer" delay at system voltages.

Table 6. Circuit Breaker Operating Times

Voltage Class	Rated Interrupting Time (Cycles)	Dead "Timer" Delay (Cycles)
500-Ky	2	30
230-kV	3	22
69-kV 100-kV	5	20
Below 69-kV	8	20

c. Other Fault-Interrupting Device Operating Times

Depending on the application, the use of other fault-interrupting devices such as circuit switchers may be allowed. Trip times of these devices are generally slower, and current interrupting capabilities are often lower than those of circuit breakers. Often circuit switchers are utilized to isolate generator step-up transformers from the transmission breakers. The dead "timer" delay on circuit switchers is typically 15 seconds and consequently, these devices usually are not reclosed.

4. Excitation System and Power System Stabilizers

The excitation system shall operate in the automatic-terminal-voltage regulation mode. For planned operation in manual mode, the plant operators shall obtain the approval of the Duke SOC in advance. For unplanned, forced operation in manual mode, the plant operators shall notify the SOC within 1 hour of switching to manual mode. Operation in the manual mode for extended periods shall only be permitted when approved by the SOC.

All new or replacement voltage regulators are required to have a load compensation circuit. Based on system conditions, it may become necessary to add load compensation to existing systems. In applications where needed, load compensation is used to control voltage at a point beyond the generator terminals (line-drop or transformer-drop compensator). The compensator is typically set to account for 50% to 80% of the transformer impedance. Generators whose terminals are tied directly together (cross-compound, hydro, etc.) require operation in a droop compensation mode to ensure stability. Droop compensation effectively regulates the voltage at a point behind the generator terminals (within the generator). In general, no two generators should be set to regulate the same point on the electric system.

A Power System Stabilizer (PSS) uses auxiliary stabilizing signals to control the excitation system to improve power system dynamic performance. For generators that have a PSS, Duke ET will determine if the PSS needs to be put into service and will work with the generator operator to calculate appropriate settings. Based on system conditions, it may become necessary to add the PSS prior to the installation of new or replacement systems.

The latest IEEE Std. 421.4, *Guide for the Preparation of Excitation System Specifications*, should be consulted in designing the excitation system. Additional requirements or a change in technical specification may be identified as a result of system studies.

The excitation system is critical to the overall system performance. Therefore, *Duke ET* shall have control over and final approval of the settings for these systems (gains, time constants, limiters, etc.). *Duke ET* reserves the right to specify these settings initially or revise the settings at any time during the life of the generator as warranted by system conditions.

Projects shall have a maintenance and testing program for excitation systems in compliance with applicable NERC Operating & Planning Standards and Policies.

5. Governor Speed and Frequency Control

A speed governor system is required on all generators. The governor regulates the output of the generator as a function of system frequency and desired MW output. This function is called the governor's 'droop' characteristic and must be coordinated with the governors of other generators located within the same control area, to assure proper system response to frequency variations. All speed governor systems must respond to system frequency changes to help maintain the stability of the power system. The speed governor system shall have a droop characteristic settable between three and seven percent and typically set to five percent. Droop equals change in frequency or speed, in per unit of nominal, divided by change in generator load, in per unit of full load. An example equation is: 0.05 = (0.1/60)/0.0333; where if a generator has a 5% droop setting, a system frequency change of 0.1 Hz, will cause the generator load to change by 3.33% (ignoring deadbands and other non-linearities).

See NERC Operating Policy 1 – Generation Control and Performance for additional information on speed governor operation.

Projects shall have a maintenance and testing program for the governor control systems in compliance with applicable NERC Operating & Planning Standards and Policies.

6. Voltage Regulation and Reactive Power Requirements

a. Duke Transmission System Voltages

Duke ET operates its transmission system within the voltage guidelines defined below. Projects shall have the capability to operate within the full voltage range at the Connection Point so as not to restrict the operational range of the transmission system. Explanation of the meaning of the terms Absolute Voltage Limits, Contingency Voltage Drop, and Voltage Regulation are available in the Definitions section.

Bulk Transmission System Voltage Guidelines

Nominal	Absolute Voltage Limits		Maximum Allowable
Voltage (kV)	Minimum_	Maximum	Contingency Voltage Drop
230_	95%	105%	5%
500	100%	110%	5%

44 & 100 kV Transmission System Voltage Guidelines

Nominal	Absolute Voltage Limits		Voltag	e Regulation
Voltage (kV)	Minimum	Maximum	Normal	Contingency
100	95%	107%	6%	7%
44	94%	109%	8.5%	10%

b. Voltage Schedules and Operation of the Project

Major generators (as determined by *Duke ET*) are provided voltage schedules by the *SOC*. Voltage schedules are necessary for efficient and reliable electric power transmission and for adequate service to loads. The voltage schedules establish operating requirements for generators and may be set for seasons, holidays, days of the week, and time of day. These schedules may be changed at any time by the *SOC* coordinator to meet transmission system requirements. When requested by the *SOC*, *Project Operators* shall provide the date, duration and reason for a generator not maintaining the established voltage schedule.

Generator step-up (GSU) transformers (unit transformers) must have taps that cover the entire range of possible transmission system voltages given in the previous section, with less than or equal to 2.5% difference between adjacent taps. The GSU tap must be set to allow the generator to produce or absorb reactive power between 0.95 leading and 0.90 lagging power factor to meet the voltage schedule. At the same time, the plant electrical system must be designed so that all modes of unit operation are not restricted by transmission system operation within the voltage range given in the previous section. In the project design phase, the *Project Sponsor* shall demonstrate to *Duke ET* that the *Project* meets these requirements.

Dynamic sources of reactive power, such as synchronous generators, are necessary to operate a reliable power system. Therefore synchronous generators are required to participate in voltage regulation by meeting voltage schedules. Operating requirements for each *Project* are determined by facility studies and/or operating experience with similar projects. Operating requirements may be refined based on actual *Project* operating experience or future system changes.

1) Synchronous generators and projects with solid-state inverters are required to produce or absorb reactive power up to the temporary thermal capability of the generator during disturbances.

The voltage regulator is set to maintain constant voltage rather than constant power factor. The regulator set point is coordinated with voltage schedules in the area. The *Project* generators are not required to operate at more than 105% or less than 95% of the nominal voltage rating of the generators under steady state conditions. However, seasonal adjustment of the transformer tap settings may be required when voltage schedules are changed by the *SOC* coordinator. It is the *Project Sponsor/Operator's* responsibility to ensure that the voltage regulator is initially set up correctly to allow the full range of adjustability. If the midpoint of the range of adjustability (or operating range "window") is not set correctly the ability of the regulator to be adjusted may be significantly reduced in either the raise or lower position.

Projects using induction generators (without solid-state inverters) are usually not required to participate in voltage regulation, however they must not adversely affect voltage schedules. The facility studies determine the reactive power capability necessary to insure that these voltage schedules are maintained.

c. Reactive Power and Voltage Regulator Requirements

Each generating facility shall supply at least 0.395 Mvars (0.93 lagging power factor) of dynamic reactive power for each MW supplied at the *Connection Point*. The facility shall have the capability to supply this reactive power on a continuous basis at rated MW and the transmission voltage stated below:

100 kV and below	1.00 pu
230 kV	1.00 pu
500 kV	1.05 pu

Each generating facility shall absorb at least 0.251 Mvars (0.97 leading power factor) of dynamic reactive power for each MW supplied at the *Connection Point*. The facility shall have the capability to absorb this reactive power on a continuous basis at rated MW and the transmission voltage stated below:

100 kV and below	1.05 pu
230 kV	1.04 pu
500 kV	1.09 pu

1) Synchronous generators and projects with solid state inverters. Each *Project* of this type must also have a voltage regulator capable of maintaining stable voltage at the generator terminal, within 0.5 percent of any set point. The operating range of the regulator shall be at least plus or minus five percent of the rated voltage of the generator.

The generator continuous reactive capability between 0.95 leading and 0.90 lagging power factor shall not be restricted by any main or auxiliary equipment, e.g. main or auxiliary transformer settlings, hydrogen cooling system, stator water cooling system, equipment voltage or current ratings, control, protection and so on. The generator step-up transformer shall be chosen so as not to limit the real or reactive power output of the generator. IEEE Standard. C57.116, IEEE Guide for Transformers Directly Connected to Generators, should be consulted when specifying the step-up transformer turns ratio, impedance, etc.

Projects shall have a program to verify the gross and net reactive power capability in compliance with applicable *NERC Planning Standards*.

2) Projects using induction generators (without solid-state inverters) shall provide at a minimum, sufficient reactive power capability or the 'equivalent' to deliver the *Project* output at unity power factor at the *Connection Point*. 'Equivalent' reactive power includes adding shunt capacitors at locations other than at the *Connection Point* or the Generation Site or acquiring sufficient reactive power from Duke or another utility. *Duke ET* determines the acceptable locations for 'equivalent' reactive using facility studies.

Power factor correction capacitors added to the *Project* to meet the unity power factor requirement may need to be switchable (while energized). Depending on the size of the *Project* and location on the system, these capacitors may need to be switched to participate in voltage regulation. The control methods and set points for switching these capacitors will be coordinated by *Duke ET* with voltage schedules in the area.

7. Voltage and Frequency Operation During Disturbances

Power system disturbances initiated by faults, forced equipment outages, etc., expose connected generators to oscillations in voltage and frequency. It is important that generators remain in service while the oscillations are damped and the system returns to a stable operating point. Therefore each generator must be capable of continuous operation at 0.95 to 1.05 pu voltage and 59.5 to 60.5 Hz and limited time operation for larger deviations. Nearly all generators have inherent capability for off-nominal operation. Over/under voltage and over/under frequency relays are normally installed to protect the generators from extended off-nominal operation. To insure that the *Project* generator is not tripped prematurely, the required time delays for setting these relays are presented in the Protection Requirements section.

To avoid large-scale blackouts that can result from the excessive generation loss during a disturbance, underfrequency load shedding has been implemented throughout the Eastern Interconnection. When system frequency declines, loads are automatically interrupted in discrete steps, with most of the interruptions between 59.3 and 58.6 Hz. Load shedding attempts to stabilize the system by balancing the generation and load. It is imperative that generators remain connected to the system during frequency declines, both to limit the amount of load shedding required and to help the system avoid a complete collapse. This need, as well as the restricted ability of some generators to withstand off-nominal frequency operation, has been taken into account in the relay-setting delays provided in this document.

To avoid voltage collapse within the *Duke ET System*, undervoltage load shedding may be implemented in the future. If required in the future, the *Project* may be required to add undervoltage relaying and coordinate undervoltage relay settings with the Duke undervoltage load shedding program.

For those generators connected to Duke through a tapped transmission line, a 'local island' is created when the breakers at the ends of the transmission line open. This leaves the generator and any other loads that also are tapped off this line isolated from the power system. Delayed fault clearing, overvoltages, ferroresonance, extended undervoltages, etc. can result from this 'local Island' condition and are therefore not allowed to persist on Duke transmission facilities. For protection, special relaying and settings are used to disconnect the generator(s) in the 'local island.' (See also Protection Regulrements section.)

E. Protection Requirements

The protection requirements identified in this document are intended to achieve the following objectives:

- 1. Insure safety of the general public, Duke ET personnel, and Project personnel.
- 2. Maintain dynamic stability.
- Prevent or minimize equipment damage.
- 4. Minimize system voltage disturbances.
- Minimize adverse operating conditions on the Duke ET System and to Duke's customers.
- 6. Permit the Sponsor to operate the *Project* in parallel with the *Duke ET System* in a safe and efficient manner.

To achieve these objectives, certain protective equipment (relays, circuit breakers, etc.) must be installed. These devices ensure that faults or other abnormalities initiate prompt and appropriate disconnection of the *Project* from the *Duke ET System*. Protective equipment requirements depend on a number of issues. Significant issues that could affect these requirements include:

- The configuration of the Project. See Figures 1 and 2 below for examples
- The Connection Point to the power system.
- The level of existing service and protection to adjacent facilities (including those of other Duke ET customers and potentially those of other utilities).

In addition, certain modifications and/or additions to the *Duke ET System* may be required for *Project* connection. Each individual connection will require a protection system consistent with these technical requirements. *Duke ET* will have final approval of the protective devices required by the *Project. Duke ET* works with *Project Sponsors* to achieve an installation that meets the *Project Sponsor's* and Duke's requirements.

Duke ET cannot assume any responsibility for protection of the *Project. Project Sponsors* are solely responsible for protecting their equipment In such a manner that faults, imbalances, or other disturbances on the *Duke ET System* do not cause damage to the *Project* facilities. The sponsor is also expected to provide proper protective systems to ensure *Project Sponsor's* equipment does not adversely impact the Duke transmission system. Sponsor should follow IEEE guide for Utility-Consumer connections (IEEE C37.95) and IEEE guide for AC generator protection (IEEE C37.102-1995).

1. Protection Criteria

The protection system must be designed such that the *Project* generating equipment or connection point is automatically isolated for the following situations:

- Internal faults within the Project.
- External faults within the Duke ET System
- Conditions that indicate abnormal operation, including islanding of the Project.

The information below is provided to identify general protection practices as applied to *Duke ET System* transmission lines and connections thereto. The protection schemes necessary to integrate the *Project* must be consistent with these practices and the equipment used to Implement them.

a. All voltages

- A generator may interconnect to an existing transmission line only if the line protection can be coordinated without compromising reliability, system stability, or quality of service to Duke 's existing customers.
- Relays, breakers, etc. are required at the Connection Point or the Interconnecting Substation to isolate Duke ET equipment from the Project (or the distribution system containing the Project) during faults or other system abnormalities.
- The Project is to be synchronized to the power system. An automatic synchronizing function must supervise all closures of the breaker connecting the generator to the power system.

- Any breaker dedicated for the sole purpose of isolating the interconnecting power system or generator shall open all three phases.
- Breaker automatic reclose supervision will be required at the Interconnecting Substation and/or electrically 'adjacent' stations; e.g., hot bus/dead line check, synchronization check, etc.

b. 500-kV

- Two independent sets of directional line protection schemes with separate pilot communication for each relay set shall be installed at each line terminal to trip the line terminal breakers.
- Total fault clearing time with a pllot scheme must not be more than four cycles, including relay and breaker time.
- Relays shall provide back-up directional distance protection for loss of communication channel.
- Line protection may be required to be compatible with Duke ET equipment.
- Breaker failure relay (BFR) protection at the *Project Sponsor's* facilities is required. Total time for BFR scheme fault-clearing must not exceed stability limits as defined for safe operation of the transmission system.
- System reliability and stability studies shall determine reclosing requirements of the transmission line/tap line.

c. 230-kV

- Two independent sets of directional line protection shall be installed at each line terminal to trip the line breakers.
- One of the protection schemes shall use pllot communications for fast clear of all line faults.
- 3. Total fault clearing time with a pllot scheme must not be more than four cycles, including relay and breaker time.
- 4. Pilot scheme must be compatible with existing Duke equipment.
- 5. Relays shall provide backup directional distance protection.
- Breaker fallure relay (BFR) protection at the *Project Sponsor's* facilities is required. Total time for BFR scheme fault-clearing must not exceed stability limits as defined for safe operation of the transmission system.
- System reliability and stability studies shall determine reclosing requirements of the transmission line/tap line.

d. 44 & 100-kV

- Directional distance line protection with back up overcurrents shall be installed at each line terminal to trip the line terminal breakers.
- A pilot communication scheme may be required. A scheme common to both relay sets is acceptable.
- Total fault-clearing times, with or without a pilot scheme, must be provided for Duke ET review and approval. Breaker operating times, relay models, and relay settings must be identified specifically.

- If a pilot scheme is necessary, it must be compatible with existing Duke equipment.
- If a pilot scheme is necessary, relays shall provide backup protection for loss of channel.
- Breaker failure relay (BFR) protection at the *Project Sponsor's* facilities is required. Total time for BFR scheme fault-clearing must not exceed stability limits as defined for safe operation of the transmission system.
- System reliability and stability studies shall determine reclosing requirements of the transmission line/tap line.

2. Implications for Project Connection to an Existing Customer Service Substation

Many generation projects are proposed for integration into utility power systems through a transformer that is designed only to serve loads; e.g., connection at voltages normally at 24-kV or below.

Existing facilities may have protection only on the high-voltage side of the transformer; other installations may use a circuit switcher or breaker with relay control. The device and associated relays (if any) at these sites are provided to isolate the *Duke ET System* from faults within the transformer and act as backup to the customers' (feeder) protective devices. The existing protection at these installations was applied under the assumption that there was not a source from the low-voltage side to feed faults in the transmission system.

Responsible and thorough protective relaying strategies are necessary when generation is connected into these sites. Some issues to consider are:

- 'Neutral shift' can be attributed to connection into stations with a primary (high-voltage) side delta, secondary (low-voltage) side wye-grounded (D-YG) transformer.
- Ferroresonance is also cause of concern, regardless of transformer connection.
- Equipment damage, relay performance, and saturation of measuring devices are only a few of the Issues.

Primary and/or backup relays used for detection of faults in the power system may be required at the *Project* as well as the *Connection Point*. Usually, changes to existing protection and reclosing schemes are not limited to those at the *Connection Point*.

3. Protection Measures

Under all circumstances, generators *Infeed* current and/or voltage effects to faults within the transmission system. The duration of this *Infeed* varies with generator size, type, and excitation. The magnitude of this *Infeed* depends on the fault type, system configuration, and fault location. The discussion below describes how relaying works and identifies the conditions under which relay schemes must operate:

- Infeed detection to phase and ground faults
- İslanding
- Synchronizing and reclosing

Unique problems related to system configuration

a. Phase fault detection

Normally, phase overcurrent (type 50/51) and neutral overcurrent (type 51TN) relays are provided to detect abnormally high currents. These non-directional relays may not be able to sense generator *Infeed* in the power system.

Infeed detection for faults within the power system usually requires directional current-sensing or directional power relays to remove the *Project's* contribution to the fault. Zone-distance relays (type 21) can also serve this need. However, some generation projects (generally 'small-capacity') may not contribute sufficient *Infeed* to power system phase faults to make distance-relay detection feasible. In these cases, relays at the *Project* need to provide the necessary detection and fault isolation.

b. Ground fault detection

Ground fault detection has varying requirements. The most significant consideration in ability to detect ground faults on the utility power system is the winding configuration of the transformer connecting the *Project* to the transmission system. The scenarios below assume that the *Project* is connected to the low-voltage side of this transformer.

1) Transformer grounded wye connection on the transmission side

If the transformer is connected in grounded-wye on the primary (high-voltage) side and delta on the secondary (low-voltage) side (YG-D), then a ground overcurrent relay (type 51TN) connected in the neutral of the wye is used to provide detection. This relay also protects the integrating transformer. This arrangement also applies to a grounded-wye primary, grounded-wye secondary connected (YG-YG) transformer with delta tertiary. Either of these connections provide what is often referred to as a 'ground source' for the wye grounded terminal(s). The measured quantity in the transformer grounded-wye neutral is caused by zero-sequence circulating currents in the delta winding during ground faults.

If the generator/grounded-wye transformer contributes over 30% of the total ground current for a line phase to ground fault, then additional line protection may be required to safely isolate faults on the transmission system.

2) Transformer Delta Connection on the Transmission Side

Under the second common scenario (the most common configuration used at *Duke ET* customer service substations), the connecting transformer is D-YG. For ground faults on the high voltage system, protective relaying cannot detect zero sequence current at this location unless a ground source (grounding bank) is connected to the high-voltage side of the transformer. Protective relay operation at the remote transmission line terminal(s) will isolate the line. However, the generator *Infeed* (voltage effect) will continue to energize the transmission line and,

with one phase grounded, can result in significant overvoltages (neutral shift). Thus a voltage protection scheme must be applied to this situation to detect the fault and trip the generator and/or the *Project* as rapidly as possible.

A detection method for this situation uses voltage sensing devices on the primary side of the transformer connected phase-to-ground. The voltage sensing shall monitor all three phases in an open delta connection or monitor one phase in an over/under voltage scheme.

Pilot trip from the end(s) of the transmission line is an acceptable alternative. A grounding bank connected to the high side (delta side) of the interconnecting power transformer is another acceptable alternative.

c. Islanding

Islanding describes a condition where the power system splits into isolated load and generation groups, usually when breakers operate for fault clearing or system stability remedial action. Generally, the 'islanded groups' do not have a stable load to generation resource balance. However, it is possible that, under unique situations, generator controls can establish a new equilibrium in an islanded group.

When *Duke ET* customer loads are being served over the utility's transmission system, where generation is also interconnected, implications of Islanding must be addressed to minimize adverse impacts on these loads. If a generator can be islanded, then additional protection is required to prevent this. Based on protection studies either a transfer trip scheme will be required or additional relays at the *Project* will be required to monitor voltage and frequency. The additional relays are applied as necessary to protect *Duke ET* customer loads from damage: over/under voltage (type 59/27), and over/under frequency (type 81). These relays are Intended to trip the generator for the large voltage and frequency deviations that would tend to occur during a 'local' island condition. However, they are also set so the generator does not trip for the less severe deviations that could occur during most major disturbances on the Interconnected power system.

d. Synchronizing and Reclosing

The *Project* generator(s) shall be synchronized to the power system. The point of synchronism depends on the configuration of the *Project's* connection. All closes of the breaker synchronizing the *Project* generator to the power system must be supervised by an automatic synchronizing function. The breaker used to synchronize the generator to the power system is usually the dedicated generator breaker.

e. Line Reclosing

If the *Project* includes a synchronous machine and connects to an existing line, automatic reclosing schemes at the remote line breakers may include either time delay or instantaneous reclosing. The reclosing time intervals are based on system requirements. Typical reclosing times are instantaneous (approximately 20-30 cycles) and/or voltage supervised reclosing (1.5 seconds). Even if an existing line is set up for time delay reclosing *Duke ET* reserves the right to

change the reclosing to instantaneous reclosing if the system requirements change.

If Duke ET's line reclosing is instantaneous and no other customers are on that line then Duke ET may elect to delay reclosing for the Project's generators. Duke ET reserves the right to change the reclosing back to instantaneous if the system requirements change. The Project Sponsor/Operator should be notified well in advance of any changes in the reclosing times to allow the Project Sponsor/Operator to make any necessary adjustments. If the instantaneous reclosing still presents a problem then the Project Sponsor/Operator may want to consider some other options to insure that the system will not reclose back until their generators are off line. There are two options the Project Sponsor/Operator may want to consider:

Option #1. Transfer Trip. The transfer trip signal can be transmitted via a carrier channel or by transmitting over a leased phone line. In addition transfer reclose can be added at an additional cost. This will help insure that the *Project* has received a trip signal before *Duke ET* closes back. If the signal is not received then the source breaker will close time delay regardless of the situation. The time delay reclose will be voltage supervised.

Option #2. Voltage Supervision On Instantaneous Reclosing. A potential device along with an undervoltage relay can be installed to help insure that Duke ET will only reclose if the relay senses a dead line. The voltage sensing devices can be installed on one phase, two phases or even all three phases depending on what the Project Sponsor/Operator desires.

f. Disturbance Monitoring

Unique and unanticipated protection problems can result from the changed system configuration due to connection with the *Project. Duke ET* may, at its discretion, install monitoring equipment to identify possible protection scheme problems and to provide power quality measurements of the new configuration. If relay performance indicates inadequate protection of the *Duke ET System*, the owner of the *Project* will be notified of additional protection requirements. The monitor provides information similar to that of an oscillograph or fault recorder. The availability of current and voltage measurements determines the number of channels for the device. Monitoring equipment is also installed to aid in the understanding of the electrical phenomena, such as overvoltages and ferroresonance, that can be associated with these projects. (*Duke ET* plans to use the information acquired to update future editions of this document.) Remote access to monitored quantities is often accomplished using communication equipment.

4. Protective System Coordination

A relay coordination study will need to be performed to insure proper operation of the generator and/or transmission line protection equipment. The *Project Sponsor* shall provide all requested protective relay drawings, protection settings, setpoint calculation studies, and associated equipment data for protective relays that will detect faults on the *Duke ET System* for a coordination study and design review. Any *Project* settings that will not coordinate or will adversely affect the proper operation of the transmission system will need to be adjusted.

Adequate protection scheme redundancy should be considered to ensure local isolation of faults. In addition, protection scheme modifications should be considered to remove any single points of protection scheme failure identified that could require remote station devices to isolate local faults.

5. Protective System Maintenance

The *Project Operator* will perform *Project* equipment maintenance on a regular schedule. This is to include the following:

- Functional testing of trip circuit
- Functional testing of interrupter
- Calibration testing of protective devices settings
- Inspection and maintenance of power dc sources
- Inspection and maintenance of interrupter

6. Protective System Fault Analysis

All operations of protective devices within the *Project* should be reviewed and documented. This information should be available to *Duke ET* on request to assist in analyzing fault operation on the *Duke ET System*. To facilitate the analysis of system disturbances and the evaluation of system operation, fault recorders may be required on certain types of complex substations and at all major generating stations connected to the *Duke ET System*. Fault recording functions in microprocessor relays may provide the detail data needed to perform the analysis.

7. System Modifications Beyond the Connection Point

System modifications to the *Project* must be reviewed by *Duke ET* before changes are made. These changes are defined as changes in interrupters, lines, transformers, protective devices and protective settings. This review is needed to insure proper operation of the power systems and coordination of protective devices,

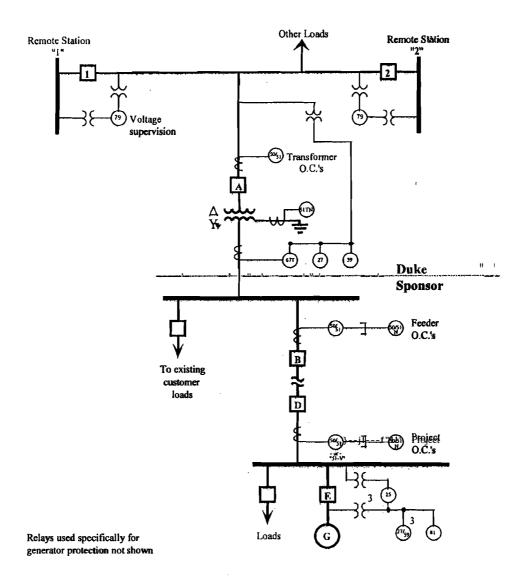


Figure 1 Integration of Generation Into an Existing Customer Service

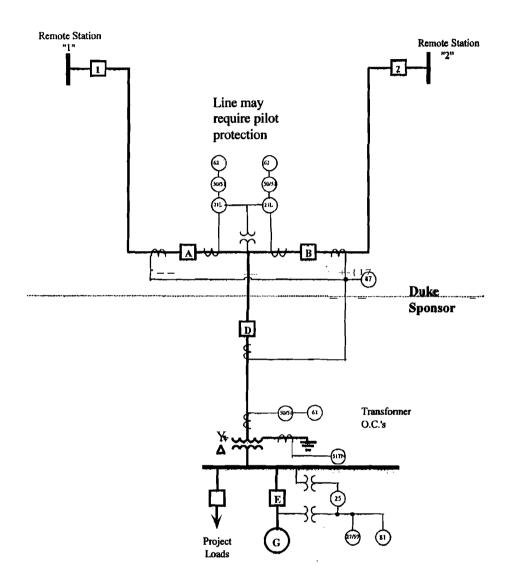


Figure 2 Integration of Generation Into a Transmission Line

F. System Dispatching, Operation & Control, Power Scheduling, and Reserves

1. General

All *Project Operators* are required to contact the Duke *SOC* prior to starting generation and connecting the generation to the transmission system. In addition, metering that is telemetered to the Duke *SOC* is required for all *Projects*.

2. Scheduling

Projects may be required to submit energy schedules to the Duke SOC prior to the hour of operation. This requirement is dependent on the size of the generation output, the service that the *Project* is supplying and the location of the *Project*'s delivery. If the *Project* is delivering its output outside the Duke Control Area, an hourly schedule must be submitted. All schedules must be submitted in accordance with Duke Power's scheduling standard. In addition, for deliveries outside of the Duke Control Area, transmission reservations and access must be acquired through the Duke OASIS in accordance with the Duke's Open Access Transmission Tariff.

3. Load Following

If Duke has entered into a contract for the *Project* to provide Load Following service, then an agreement between the parties will be developed that specifies the terms and conditions of that service. At a minimum, telemetry will be required from the *Project* to the Duke *SOC*.

4. Regulation

In order for a *Project* to provide regulation service to Duke, the *Project* must be under the Duke System Operating Center's Automatic Generation Control (AGC). Pulsing capability of the unit must be provided to the *SOC*, and the *Project* must be operating under the terms and conditions of the contract that will be established for the *Project* to provide Regulation Service.

5. Reserves

If Duke has entered into a contract for the *Project* to provide operating reserves to the Duke Control Area, then an agreement between the parties will be developed that specifies the terms and conditions of that service. At a minimum, the capacity of the *Project* must be under contract to the Duke *SOC* for its use as specified in the agreement.

G. Metering and Telecommunication Requirements

All Projects that are connected to the *Duke ET System* will require revenue-accuracy-metering equipment (i.e. metering enclosure with meter and associated equipment, instrument transformers, and certain interface enclosures with associated isolation devices). This section states the minimum requirements for metering and telecommunication associated with a generation connection or *Interconnection* to the *Duke ET System*,

1. Supervisory Control and Data Acquisition (SCADA)

Requirements will be determined on a case-by-case basis depending on the location of the generating facility, the number and size of the units, and the extent to which the SOC will control the generators.

Normally, all generators larger than 10 MVA or sites with greater than 50 MVA aggregate capacity must be equipped with *SCADA* to ensure that the *SOC* has the information necessary for monitoring response to *SOC* operating instructions and for maintaining system reliability.

The following data may be required:

- Generator breaker(s) status (if not installed, then the status of the generator isolation device(s) shall be provided instead
- Generator step-up transformer high voltage breaker status
- Status of any other high voltage breaker at the site
- Status of the Connection Point isolation device(s)
- Generator MW and MVAR output
- Voltage of the bus controlled by the generator(s) (may be its own low voltage bus
 or the bus at the high voltage terminals of the step-up transformer
- Generators providing Automatic Generation Control (AGC) service will require additional SCADA capability

2. Metering

Metering equipment should be installed, if possible, at the *Connection Point*. If not installed at the *Connection Point*, then power transformer and/or line losses will need to be considered.

a. Metering Equipment Requirements

A solid state meter shall be used to measure the real and reactive power interchange between the *Duke ET System* and the *Project*. Three-element, three-phase, four-wire meters shall be utilized on wye connected power systems. Two-element, three-phase, three-wire meters shall be utilized on delta connected power systems.

A bi-directional watt/var-hour meter should be utilized to measure the power flow in and out of the *Duke ET System*.

For metering equipment located in the *Project* substation, the installation of a metering bypass is suggested, but not required. For the replacement of failed or malfunctioning equipment a metering bypass is necessary to maintain power flow to the *Project*. If a metering bypass is not installed, an outage will be required to replace the falled or malfunctioning equipment.

The metering devices must be fully compatible (approved meter type and communication media) with *Duke ET System*'s remote metering and data acquisition system.

b. Meter Accuracy

Meters shall be calibrated to 0.5% accuracy at unity power factor for both full load and light load. These meters shall be calibrated to 1.0% accuracy for 0.5 power factor at full load. Metering accuracy limits are stated in the following table.

	METER ACC	URACY LIMITS	
	Watt-hour Function		Var-hour Function
Full Load	Power Factor	Light Load	Power Factor
+/- 0.5	+/- 1.0	+/- 0.5	+/- 1.0

Notes:

- Watt-hour and var-hour functions should be tested in both directions of energy flow (In and Out).
- When compensating for transformer or line loss, utilize stated limits above or 5% of desired compensation, whichever is greater.
- The meter shall be tested with compensation applied to obtain a true test of the installation.

Test Points	Volts	Amps	Power Factor
Full Load	120	5	1.0
Power Factor	120	5	0.5
Light Load	120	0.5	1.0

c. Instrument Transformers

Voltage and current transformers shall be 0.3% metering accuracy class for both magnitude and phase angle over the burden range of the installed metering circuit. Instrument transformer correction factors may be applied to the meter to adjust the meter for inaccuracies associated with the secondary burdens in the current transformer and voltage transformer circuits. In bi-directional situations where there are significant differences in the magnitude of capacity delivered to the *Duke ET System* compared to the load supplied by it; good engineering practices should be in place to accurately meter power flow in both directions. All instrument transformers shall comply with ANSI/IEEE Standard C57.13.

d. Loss Compensation

If the metering is not located at the *Connection Point*, then power transformer and/or line loss compensation will need to be considered. *Duke ET* approved power transformer and/or line loss compensation values should be applied to the meter to properly compensate for the losses in the power transformer and/or line.

e. Access to Metering Data

If access to the meter is required, proper security measures must be taken to ensure the Integrity of the meter is not compromised. If data pulses are required from the revenue meter, then the appropriate interface box with associated equipment must be installed to properly protect the revenue meter. If an additional information meter is requested, good engineering practices must be adhered to when terminating the connections in the meter circuit to ensure the integrity of the revenue-accuracy metering circuit is intact.

f. Station Service Power

Metering requirements for the *Station Service* Power, if any, will be determined on a case-by-case basis,

g. Calibration of Metering Facilities

Metering facilities shall be tested and calibrated if necessary every two years. More frequent test intervals may be negotiated. All interested parties or their representatives may witness the calibration tests. Calibration records shall be made available to all interested parties. The accuracy of the standard utilized for calibration purposes shall be traceable to the National Institute of Standards and Technology, (NIST).

3. Voice Communications

Voice communication is required between the Duke SOC and the *Project Operator*. A typical phone line at the *Project* may be sufficient to supply this communication path. In the event that the *Project* is supplying additional services (AGC, load following, reserves, system restoration, etc.) or if the *Project* is in excess of a specified generation capacity, back-up communication with the *Project* may be necessary and can be specified by Duke Energy.

Independent voice communications for coordination of system protection, control, and maintenance activities between Duke and the *Project* may be required in addition to the voice communications specified above.

4. Data Communications

All generating facilities and transmission facilities are required to have in place, a means of transmitting monitoring, accounting, and control data where appropriate to the Duke Energy control center(s).

- a) SCADA requirements consist of either leased phone lines, microwave channels, or fiber-optics from the site to the *SOC* or the *TCC*. Factors involved in selecting a type of circuitry are availability, proximity to the site, and cost. Fiber is preferred. These are dedicated channels and are not redundant.
- b) Data for AGC calculations and control is transferred to both of the above centers at a telecommunications rate of 2400 baud.
- c) Accounting data is transferred from the site through an on-site Remote Terminal Unit (RTU) to the centers in a, above through any one of the above mentioned data communication circuits.

5. Telecommunications for Revenue-accuracy Metering

A compatible and reliable communication media must be provided and maintained, to enable *Duke ET* to interrogate the meter, collect, merge, and store metering and usage data with *Duke ET System*'s remote metering and data acquisition system.

6. Telecommunications for Control & Protection

Telecommunication channels may be used for Pilot Relay Protection or Direct Transfer Trip if performance of the channel and the equipment meets the Control and Protection requirements of the connection.

Communications for Protection must function at the full performance level before, during, and after any power system fault condition (Service Performance Objective Class A per IEEE Standard 487).

a. Speed of Operation

Throughput operating times of the telecommunications system must not add unnecessary delay to the clearing or operating times of protection or remedial action schemes. Maximum permissible cleaning times for faults are specified in Protection Requirements section of this standard. The throughput operating times of the telecommunications system is only a portion of that total cleaning time.

b. Equipment Compatibility

In order to provide maintainability and operability between the *Project* and the *Duke ET System*, teleprotection terminal equipment such as transfer trip units shall be functionally compatible. 'Tone' equipment must be of the same manufacturer and type. The need or implementation of peripheral capabilities such as signal counters, test switches, etc. are not required to be identical to those used at *Duke ET* facilities. *Duke ET* prefers the use of terminal equipment that is the current Duke standard for the control application. *Duke ET* will consider the use of alternative equipment and/or technologies as proposed by the *Project Sponsor* as long as the equipment is suitable for the purposes of the control application required.

H. Exceptions

The requirements specified in this section, Facility Connections Requirements – Generation and Interconnection Facilities, apply to all generators. New contracts should be written to comply with this document. Existing contracts take precedence over these requirements. Existing non-compliant generators must submit a plan and schedule for meeting the requirements. Under rare circumstances the *Project Sponsor/Operator* may be granted an exemption from meeting one or more of the requirements.

V. REFERENCES

Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.269

National Electrical Safety Code (NESC)

Duke Power Safe Work Practices Manual

<u>Duke Electric Transmission Operating Procedures Manual</u>

Uniform Building Code (UBC)

ANSI/IEEE Std. 80, IEEE Guide for Safety in AC Substation Grounding

IEEE - 81 Part 1: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Potentials

IEEE - 81 Part 2: Measurement of Impedance and Safety Characteristics of Large, Extended or Interconnected Grounding Systems.

IEEE - 837, Standard for Qualifying Permanent Connections Used in Substation Grounding

IEEE - 487, Protection of Wire-Line Communication Serving Electric Power Stations

ANSI/IEEE 367, IEEE Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault

North American Electric Reliability Council (NERC) Planning Standards

NERC Operating Policy 1 – Generation Control and Performance

ANSI/IEEE - 665, Guide for Generating Station Grounding

IEEE - Std. 421.4, Guide for Preparation of Excitation System Specifications

IEEE Std. C57.116, IEEE Guide for Transformers Directly Connected to Generators

IEEE Std. C37, IEEE Standards for Circuit Breakers, Switchgears, Substations, and Fuses Standards Collection.

Summary of Key Terms Power Purchase Agreement between Southern Power Company and North Carolina Municipal Power Agency Number 1 ("PPA")

Seller:

Southern Power Company

Buyer:

North Carolina Municipal Power Agency Number 1

Source:

Cleveland County Generating Facility - Cleveland County, NC

Unit expected to be in service by January 1, 2012

Technology:

Simple Cycle gas-fired Combustion Turbine unit with fuel oil backup

Term:

January 1, 2012 through December 31, 2031

Purchase Amount:

The total generating capability of the Unit as determined prior to each Contract Year

(expected to be approximately 180 MW)

Scheduling:

The Contract Capacity and associated Energy is scheduled by Buyer on an hour-by-hour basis up to the Maximum Available Energy (subject to Buyer scheduling a minimum

output based on the Unit's operational guidelines).

Early Termination Events:

The occurrence of any one or more of the following events may cause the PPA to terminate earlier than the anticipated expiration of the Term:

- 1. <u>Material Permits Issuance Date Not Achieved</u>. Either party may terminate the PPA if all material permits for the Cleveland County Facility are not received by October 1, 2010. After such date, if Buyer elects to terminate the PPA, then Seller may reject Buyer's notice of termination and the material permits will be deemed to have been obtained.
- 2. Commercial Operation Date Not Achieved. If commercial operation of the Facility is delayed beyond the scheduled commencement date, then replacement power and/or damages may apply. If, after receipt of the material permits, Seller determines that the commercial operation date is not reasonably likely to occur by the commercial operation deadline, then Seller may terminate the PPA and liquidated damages will apply. If commercial operation of the facility does not occur by the commercial operation deadline, then either party may terminate the PPA and liquidated damages will apply.
- 3. Event of Default. Once an Event of Default has occurred and is continuing, the Non-Defaulting Party may elect to terminate the PPA in addition to any other remedies such Non-Defaulting Party may have.
- FERC Action Adversely Alters Amounts Paid to a Party Under PPA. Either
 Party may terminate if FERC takes an action that materially adversely affects the
 amounts to be paid by either Party under the PPA.

Summary of Key Terms Contract for the Purchase of Block Capacity and Energy between Southern Power Company and North Carolina Electric Membership Corporation ("Block Scheduled PPA")

Seller:

Southern Power Company

Buyer:

North Carolina Electric Membership Corporation

Source:

Cleveland County Generating Facility - Cleveland County, NC

Unit expected to be in service by January 1, 2012

Technology:

Simple Cycle gas-fired Combustion Turbine unit with fuel oil backup

Service Term:

January 1, 2012 through December 31, 2036

Purchase Amount:

Contract Capacity and associated Energy will vary during the Service Term as follows:

January 1, 2012-December 31, 2016

45 MWs

January 1, 2017 - December 31, 2018

90 MWs

January 1, 2019 - December 31, 2036

The total generating capability of the Unit as determined prior to January 1 of each

Contract Year (expected to be approximately 180 MW)

Scheduling:

The Contract Capacity and associated Energy is scheduled by Buyer on an hour-by-hour

basis in fixed "block" amounts up to the Maximum Available Energy.

Early Termination Events:

The occurrence of any one or more of the following events may cause the Block Scheduled PPA to terminate earlier than the anticipated Service Term:

- RUS Approval of Block Scheduled PPA Not Received. If Buyer had failed to receive RUS approval of the Block Scheduled PPA by April 22, 2009, either Party would have had the right to terminate the PPA. Such a termination is, however, no longer possible because RUS approved the Block Scheduled PPA on March 12, 2009.
- 2. Requested Transmission Service Not Granted. Buyer may terminate if Transmission Provider (i.e., Duke Energy Carolinas LLC) has not granted the requested transmission service necessary to deliver the output of the Unit to Buyer prior to the commencement of service from the Unit.
- 3. <u>FERC Action Adversely Alters Amounts Paid to a Party Under Block Scheduled PPA</u>. A Party may terminate if FERC takes an action that adversely affects the amounts to be paid by either Party under the Block Scheduled PPA.
- 4. Major Permit Issuance Date Not Achieved. Seller may terminate Block Scheduled PPA if all major permits for the Cleveland County Facility are not received by July 1, 2009. After such date, if Seller does not receive all major permits for the facility and, thus, terminates the Block Scheduled PPA, replacement power and/or damages may apply.

- 5. COD Not Achieved. If permits are received but commercial operation of the facility is delayed beyond the service commencement date, replacement power and/or damages may apply. If commercial operation of the facility does not occur by a date certain, either Party may terminate the Block Scheduled PPA, replacement power and/or damages may apply.
- 6. Event of Default. Once an Event of Default has occurred and is continuing, the Non-Defaulting Party may elect to terminate the Block Scheduled PPA in addition to any other remedies such Non-Defaulting Party may have.
- Force Majeure. Either Party may terminate upon the occurrence of a Force Majeure Event that renders any Contract Capacity unavailable for more than 24 Months.

Summary of Key Terms

Contract for the Purchase of Dynamically Scheduled Capacity and Energy between Southern Power Company and North Carolina Electric Membership Corporation ("Dynamically Scheduled PPA")

Seller:

Southern Power Company

Buyer:

North Carolina Electric Membership Corporation

Source:

Cleveland County Generating Facility - Cleveland County, NC

Unit expected to be in service by January 1, 2012

Technology:

Simple Cycle gas-fired Combustion Turbine unit with fuel oil backup

Service Term:

January 1, 2012 through December 31, 2036

Scheduling:

The Contract Capacity and associated Energy is dynamically scheduled by Buyer via a real-time load signal that is telemetered to the Southern Company balancing area.

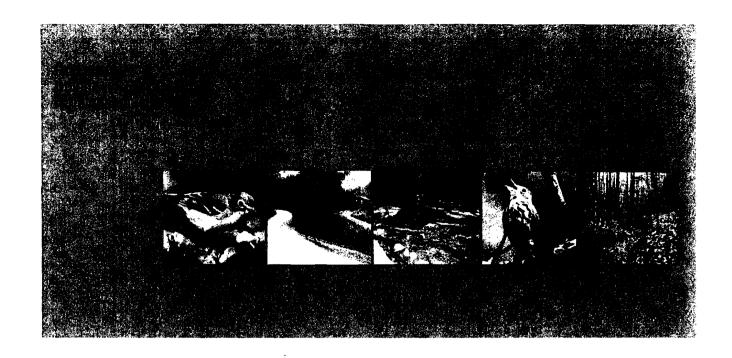
Purchase Amount:

Contract Capacity is 180 MW and associated Energy.

Early Termination Events:

The occurrence of any one or more of the following events may cause the Dynamically Scheduled PPA to terminate earlier than the anticipated Service Term:

- 1. RUS Approval of Dynamically Scheduled PPA Not Received. If Buyer had failed to receive RUS approval of the Dynamically Scheduled PPA by April 22, 2009, either Party would have had the right to terminate the PPA. Such a termination is, however, no longer possible because RUS approved the Dynamically Scheduled PPA on March 12, 2009.
- 2. Requested Transmission Service Not Granted. Buyer may terminate if the Transmission Provider has not granted requested transmission service necessary to deliver the dynamically scheduled energy to Buyer prior to the commencement of service pursuant to the Dynamically Scheduled PPA.
- 3. FERC Action Adversely Affects Amounts Paid to a Party Under Dynamically Scheduled PPA. A Party may terminate if FERC takes an action that adversely affects the amounts to be paid by either Party under the Dynamically Scheduled PPA.
- 4. Event of Default. Once an Event of Default has occurred and is continuing, the Non-Defaulting Party may elect to terminate the Dynamically Scheduled PPA in addition to any other remedies such Non-Defaulting Party may have.
- Force Majeure. Either Party may terminate upon the occurrence of a Force Majeure Event that renders any Contract Capacity unavailable for more than 24 Months.



Cleveland County Generating Facility 230-kV Bus Line (South Carolina Portion)

En innumental Report

AECOM, Inc. April 2009

Document No.: 06204-045-0002



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1.0 Introduction

AECOM Environment has prepared this Environmental Report (ER) to document the potential environmental impacts of Southern Power Company's (Southern Power's) proposed Cleveland County Generating Facility 230-kV Bus Line (Project). Southern Power is proposing the construction of a 230-kV aerial interconnect line, approximately 1.9 miles from the tie-in with the proposed Cleveland County Generating Facility (CCGF) in Cleveland County, North Carolina, to an existing Duke Energy substation site located in Cherokee County, South Carolina. The South Carolina portion of the interconnect line project will consist of a proposed route of approximately 0.86 mile of overhead interconnect line and the necessary maintained easement from the North Carolina state line to the Duke Energy substation interconnection.

This ER has been prepared to meet the requirements for environmental documentation required by the South Carolina Public Service Commission (PSC). The principal purposes in preparing this ER are to:

- identify and assess potential impacts on the natural and human environment that would result from the implementation of the proposed action;
- assess reasonable alternatives to the proposed action that would avoid or minimize adverse effects on the environment; and
- 3) identify specific mitigation measures, as necessary, to minimize environmental impacts.

1.1 Purpose and Need of the Project

Additional generation is essential to meet the current and future needs for electricity in the area. Southern Power has contracted the output of the CCGF via long-term Power Purchase Agreements. This interconnect line is required to deliver electricity and will also serve the interests of system economy and reliability of the existing transmission network.

1.2 Proposed Facilities

Southern Power Company (Southern Power), a subsidiary of Southern Company that owns and operates power generation assets that have been constructed for the wholesale market, is proposing to construct and operate a wholesale power generating facility to be known as the Cleveland County Generating Facility (CCGF). The CCGF will be located on a 283-acre site, near the intersection of Interstate 85 and the North Carolina and South Carolina state border in Cleveland County, North Carolina. The plant will have a total generating capacity of approximately 1080 MW and will be dual fueled [pipeline-quality natural gas and ultra low sulfur (0.0015% S) fuel oil]. CCGF will require construction of a 230-kV interconnect line to transmit the electrical power from the plant to the transmission grid. For the purposes of this document, the "facility" consists of the portion of the electrical interconnect line to be constructed within the boundary of the state of South Carolina. It is proposed that this portion of the interconnect line will require construction of 11 tower structures, and a permanently maintained 125-foot-wide right-of-way of approximately 0.86 mile in length.

2.0 ALTERNATIVES TO THE PROPOSED ACTION

Southern Power conducted a line siting study to determine the most practical route for the proposed interconnect line. A siting study area was delineated that included the geographic area through which practical routes for a 230-kV interconnect line connecting the proposed power plant to the existing substation located adjacent to the Duke Energy Mill Creek Combustion Turbine Substation would pass. Data was collected to characterize the siting study area and to identify any environmental, land use, or cultural resource factors that should be taken into consideration during the siting study. The three routes, also shown on Figure 1 considered most feasible are detailed below.

Alternative 1: Routing the proposed interconnect line along the North Carolina side of the North Carolina/South Carolina state line on Southern Power-owned land westward from the proposed power plant, turning approximately 20 degrees southward and crossing the state line into South Carolina to avoid an historic cemetery, then turning southward along an existing Duke Energy transmission-line right-of-way near and over the Vulcan Materials Blacksburg Quarry, and then arriving at the Duke Energy Substation.

Alternative 2: Routing the proposed interconnect line along the North Carolina side of the North Carolina/South Carolina state line on Southern Power-owned land westward from the proposed power plant, running adjacent to the historic cemetery, then turning southward crossing into South Carolina along an existing Duke Energy transmission-line right-of-way through the Vulcan Materials Blacksburg Quarry, and then arriving at the Duke Energy Substation.

Alternative 3: Routing the proposed interconnect line from the proposed power plant southwest across the North Carolina/South Carolina state line, then crossing Caveny Road and Elm Road before turning northwest and arriving at the Duke Energy Substation.

After mapping the data, it was determined that Alternative 1 will be superior to Alternatives 2 and 3 for the following reasons:

- 1. Utilizing the Alternative 1 or Alternative 2 configurations maximize the amount of interconnect line located within Southern Power-owned land, which minimizes impacts to other properties. Within North Carolina, these Alternate alignments occur entirely on property owned by Southern Power;
- 2. Utilizing the Alternative 1 or Alternative 2 configurations maximize the use of existing roads and maintained cleared lands to construct the new interconnect line and minimize the amount of newly impacted land by running parallel to the existing interconnect line within the Vulcan Quarry;
- 3. Utilizing the Alternative 1 or Alternative 2 configuration limits the potential impact to private citizen landowners to one willing family, while Alternative 3 would result in potential impacts to multiple private citizen landowners. Within North Carolina, Alternatives 1 and 2 occur entirely on property owned by Southern Power;
- 4. Utilizing Alternative 1 avoids potential impacts to the historic cemetery.
- 5. Analysis of the data collected and mapped in the siting study, which included biological and cultural resource surveys, confirms the Alternative 1 route does not affect protected species or cultural resources, and minimizes impacts to the community and property owners.

For these reasons, Alternative 1 has been identified as the preferred Alternative for the project.

3.0 Environmental Analyses

The following sections describe information reviewed and analyzed and the methods implemented by AECOM Environment scientists to evaluate the preferred Alternative interconnect line route. The project area was evaluated to identify wetlands and waterbodies, determine the probable U.S. Army Corps of Engineers (USACE) jurisdictional status of these features, and to identify historically sensitive areas.

Prior to conducting and in preparation for the field survey, AECOM Environment ecologists conducted a desktop review of the following material:

- United States Geological Survey (USGS) 7.5-minute Topographic Quadrangle Maps;
- U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) Maps;
- Proposed interconnect line route;
- USFWS lists of protected species;
- National Historic Register Information Database;
- North Carolina Department of Cultural Resources Inventory Database;
- North Carolina Natural Heritage Program Element Occurrence Database; and
- South Carolina Department of Natural Resources Rare, Threatened, & Endangered Species Inventory by County.

3.1 Wetlands

Wetland is the collective term for swamps, bogs, marshes, wet meadows, and similar areas that are often located between open water and dry land. The USACE claims jurisdiction over all "Waters of the United States". Certain activities in these waters are regulated by the USACE under the authorities granted by 33 Code of Federal Regulations (CFR), 40 CFR, Section 10 of the Rivers and Harbors Act of 1899, Section 404 of the Clean Water Act (CWA), and Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 (USACE, 2006).

The USACE and the Environmental Protection Agency (EPA) define a wetland as "an area that is inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation." This definition takes into consideration three distinct environmental parameters: hydrology, soil, and vegetation. Positive wetland indicators of all three parameters are normally present in wetlands.

The protocol for the wetland surveys was obtained from the 1987 USACE Wetland Delineation Manual (Environmental Laboratory, 1987). These methods define characteristic hydrophytic vegetation, hydric soil, and hydrologic indicators that are normally present in wetlands.

USACE Methodology

According to the 1987 USACE Wetland Delineation Manual, areas must exhibit three distinct characteristics to be considered wetlands:

 The prevalent vegetation must consist of plants adapted to life in hydric soil conditions. These species, due to morphological, physiological, and/or reproductive adaptations, can and do persist in anaerobic soil conditions;

- Soils in wetlands must be classified as hydric or they must possess characteristics that are associated with reducing soil conditions; and
- The area must be inundated either permanently or periodically at mean water depths less than 6.6
 feet (2 meters) or the soil saturated at the surface at some time during the growing season of the
 prevalent vegetation.

Vegetation, soils, and hydrology were assessed during field surveys in order to determine whether the three criteria were satisfied within each potential wetland area.

In addition, the wetlands were further characterized based on primary vegetative stratum (Cowardin et al, 1979). The wetland classifications common in Cleveland County, NC and Cherokee County, SC include the following:

- Palustrine Emergent Wetlands (PEM): Freshwater wetlands dominated by erect, herbaceous vegetation (e.g., grasslands or stands of reedy growth) are classified as PEM wetlands. They generally have less than 20% coverage by shrubs or trees;
- Palustrine Scrub-Shrub Wetlands (PSS): When freshwater wetlands are dominated by woody
 vegetation less than 20 feet tall, they are classified as PSS wetlands. They generally have greater
 than 60% coverage by shrubs and less than 20% coverage by trees; and
- Palustrine Forested Wetlands (PFO): When freshwater wetlands are dominated (i.e., greater than 50% coverage) by trees 20 feet or taller, they are classified as PFO wetlands. PFO wetlands often consist of an overstory dominated by deciduous, broad-leaved tree species and an assortment of herbaceous plants and vines in the subcanopy and ground cover.

3.2 Waterbodies

Waterbodies are typically defined as any area that in a normal year has water flowing or standing above ground to the extent that evidence of an ordinary high water mark (OHWM) is established. This includes lakes, rivers, bays, tributaries, and anthropogenic features such as canals and ditches. The USACE defines the OHWM as "line on the shore coincident with the elevation contour that represents the approximate location of the line on the shore established by fluctuations of water and indicated by physical characteristics such as shelving, destruction of terrestrial vegetation, presence of litter or debris, or changes in the character of soil".

The USACE jurisdictional term "Waters of the United States" includes navigable waters and all their tributaries and other waters where degradation or destruction could affect interstate or foreign commerce. Under this definition, any surface water connection that has a defined OHWM or is part of a continuum of wetlands, whether natural or man-made, is considered a tributary connection. Ditches and canals with weirs, culverts, or other water control structures including pumping facilities are also considered to have tributary connection, provided there is some conveyance of water from upstream to downstream. The USACE claims jurisdiction on ditches or canals that fall under this definition at the OHWM. Exclusions from this rule generally include upland cut ditches and ditches that do not connect to navigable waters or wetlands.

Waterbodies include linear water features (i.e., streams and ditches) as well as open water features. Open water features are classified as ponds, lakes, or borrow pits.

3.2.1 Waterbody Quantitative Assessment

The location and area of waterbodies within the project area were determined during field surveys, in accordance with generally accepted stream assessment protocols. At each waterbody, the waterbody top-of-bank width was estimated to provide a general perpendicular measurement. At each waterbody location, water depth, water width, substrate composition, bank height, bank slope, and water clarity were estimated. Data were recorded electronically using GPS technology and manually on standardized field datasheets

(included in Appendix A of this report) field logbooks, and aerial alignment sheet mapping for each waterbody identified during the field surveys. Photographs of each waterbody identified during the field surveys are included in Appendix B of this report.

3.2.2 Waterbody Qualitative Assessment

A general waterbody quality assessment was conducted for each waterbody identified within the survey corridor. Each waterbody was grouped into one of the following three classification groups, based on generally accepted stream assessment protocols:

- High Quality: Natural channel (no structures or dikes; no evidence of down-cutting or excessive lateral cutting); evidence of past channel alteration with significant recovery; any dikes/levies are set back to provide access to adequate flood plain; natural vegetation extends at least one or two active channel widths on each side; banks stable and protected by roots that extend to the base-flow elevation; water clear to tea-colored; no barriers to fish movement (e.g., no seasonal water withdrawals that prevent movement); many fish cover types available; diverse and stable aquatic habitat; no disturbance by livestock or man; intolerant macroinvertebrates present;
- Moderate Quality: Altered channel evidenced by rip rap and/or channelization; dikes/levees restrict
 flood plain width; natural vegetation extends 1/3-1/2 of the active channel width on each side; filtering
 function of riparian vegetation only moderately compromised; banks moderately unstable (outside
 bends actively eroding with few fallen trees); considerable water cloudiness, submerged objects
 covered with green film; moderate odor; minor barriers to fish movement; fair aquatic habitat; minimum
 disturbance by livestock or man; facultative macroinvertebrates present; and
- Low Quality: Channel is actively down-cutting or widening; rip rap and channelization excessive; flood plain restricted by dikes/levees; natural vegetation less than 1/3 of the active channel width on each side; lack of regeneration; filtering function severely compromised; Banks unstable (inside and outside bends actively eroding with numerous fallen trees); water very turbid to muddy; obvious pollutants (algal mats, surface scum, surface sheen); heavy odor; green color to water; severe barriers to fish movement; little to no aquatic habitat; severe disturbance by livestock or man; tolerant or no macroinvertebrates present.

Stream types were further classified based on the frequency and duration of water within the stream banks as defined in the National Hydrographic Dataset (USGS, 2000). The following three stream type classifications were utilized:

- Perennial: Contains water throughout the year, except for infrequent periods of severe drought;
- Intermittent: Contains water for only part of the year, but more than just after rainstorms and at snowmelt; and
- Ephemeral: Normally are natural watercourses, including natural watercourses that have been modified by channelization or manmade drainage ditches, that without the influent of point source discharges flow only in direct response to precipitation or irrigation return-water discharge in the immediate vicinity and whose channels are normally above the groundwater table. These streams may contain a transient population of aquatic life during the portion of the year when there is suitable habitat for fish survival. Normally, aquatic habitat in these streams is not adequate to support a reproductive cycle for fish and other aquatic life.

In addition to the above terminology, this report also includes terminology based on the USACE's new Jurisdictional Determination (JD) forms and associated instructional guidebook, as follows: Traditional Navigable Waterway (TNW), Relatively Permanent Waterway (RPW) for intermittent and perennial streams; and Non-Relatively Permanent Waterway (Non-RPW) for ephemeral streams.

3-3

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3.3 General Habitats

Vegetative habitats are classified by the presence of the dominant vegetation species. Defining habitats is necessary in order to assess the potential presence of wildlife, threatened and endangered species and communities, and other ecologically sensitive areas. The subject property is located near the western edge of the Piedmont physiographic province. The main habitat types were observed during the field survey consisted of planted pine, cleared grass-shrub right of way, and commercial/industrial land (active guarry).

3.4 Protected Species

AECOM Environment compiled a list of protected species (includes rare, threatened, and endangered species as well as candidate species and species of special concern) for the entire length of the proposed project (Cleveland County, NC, and Cherokee County, SC). This list is provided in Section 4.4.

Prior to field studies, aerial photography and mapping was reviewed to assess the habitat types for the study area. Field surveys consisted of pedestrian surveys conducted within the proposed interconnect line right-of-way (Figures 2 through 5). General habitats were characterized within the survey area during pedestrian surveys. These habitats were compared to the preferred habitat for each identified species to determine the likelihood of these species occurring within the project location.

3.4.1 Federally Listed Protected Species, Candidate Species, and Critical Habitat

Federally listed protected species and critical habitat are protected by the Endangered Species Act [ESA, Endangered Species Act of 1973, Public Law 93-205 (87 Stat. 884) and subsequent amendments]. The ESA is administered by two federal agencies, the USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries. NOAA Fisheries oversees marine species, and the USFWS has responsibility over freshwater fish and all other species.

3.4.2 State Listed Imperiled Species and Species of Concern

Because the project will occur in North Carolina and South Carolina, agencies from both states were consulted.

The North Carolina Wildlife Resources Commission publishes a list of Protected Wildlife Species and the North Carolina Natural Heritage Program, in cooperation with the North Carolina Department of Agriculture, publishes a list of Protected Plant Species in the state in accordance with the ESA. The State of North Carolina requires a permit to remove or take protected plant species.

The South Carolina Department of Natural Resources maintains an inventory of the Rare, Threatened, and Endangered Species in the state in accordance with the Nongame and Endangered Species Conservation Act (S.C. Code 50-15-10 to 50-15-90).

A list of protected species was obtained from the North Carolina Natural Heritage Program and the South Carolina Department of Natural Resources.

3.5 Archaeological Resources

Archaeological resources are defined as any material remains of past human life or activities which are at least 50 years old and which are of archaeological interest, including pieces of pottery, basketry, bottles, weapons, weapon projectiles, tools, structures or portions of structures, rock paintings, rock carvings, intaglios, graves or human skeletal materials.

A review of National Historic Register databases was performed to evaluate the presence of documented historic sites near the project. No sites were identified in South Carolina and the entire route within South Carolina has been determined to have been previously impacted by development or tree-farming activities.

3.6 Socioeconomics

Population demographic information from the United States Census Bureau Fact Finder (http://factfinder.census.gov) was analyzed to compare the socioeconomic similarities and differences between the areas impacted by the proposed routing alternates.

3.7 Land Use, Recreation, and Visual Resources

No changes to land use will occur except for conversion of a small area of planted pine forest to permanent cleared easement. The project will result in no impacts to recreational facilities, parks, or scenic areas. Visual resources will not be significantly impacted due to routing the Preferred Alternative along existing electric transmission line corridor and an active rock quarry.

4.0 Results

The following sections summarize the results of the surveys conducted by AECOM Environment scientists for the Preferred Alternative interconnect line corridor. Results include information regarding wetlands and waterbodies identified within the areas surveyed. In addition results from an extensive survey of a neighboring archeologically significant area are included. Figures 2 through 6 depict the locations of each of the identified features.

4.1 Wetlands

Two wetlands were identified within the South Carolina portion of the route during the field surveys. Because the proposed line will span the wetlands, these wetlands will not be impacted during construction of the interconnect line nor during maintenance of the right-of-way.

Table 2 and the paragraphs below provide a summary of the characteristics of the identified wetlands. W1ACH001 is depicted on Figure 4 and W1ACH002 is on Figure 5. Wetland field datasheets are included in Appendix A and photographs are provided in Appendix B.

	Table 1 Wetland Characteristics Cherokee County, South Carolina	g arthur second the se
Feature ID	NWI Classification *	Size (acres)
W1ACH0011	PEM	0.27
W1ACH002	PSS	0.64

W1ACHOO1 - W1ACHOO1 is a small (0.27 acre within the 125-foot-wide survey corridor), moderate-quality, PEM wetland. It crosses the existing transmission line right-of-way. Dominant vegetation consists of soft rush (Juncus effuses), bushy bluestem (Andropogon glomeratus), and cattail (Typha latifolia).

W1ACH002 - W11 ACH002 is a small (0.64 acre within the 125-foot-wide survey corridor), moderate-quality, PSS wetland. Water enters this wetland from a Cullwert under a dirt road at the northeastern corner; however, there is not a defined channel within the wetland. Some beaver activity was noted during the survey. The dominant vegetation within the shrub layer is black willow (Salix nigra); and soft rush, bushy bluestem (Andropogon glomeratus), and cattail are dominant in the herb layer.

4.2 Waterbodies

Table 3 is a summary of the waterbodies in South Carolina identified during the field surveys along the interconnect line route. Figures 2 through 5 show the location of each identified waterbody along the entire route (North Carolina and South Carolina portions), field datasheets are included in Appendix A, and photographs are provided in Appendix B.

Only one waterbody feature, an ephemeral roadside ditch, was identified along the proposed interconnect line corridor on the South Carolina portion of the project.

	: ;				e 2 aracteristics , South Caro		esta esta esta esta esta esta esta esta	
Feature ID	Description	Bank Width (feet)	Water Width (feet)	Water Depth	Substrate	Classification ^c	Quality	Natural/ Artificia
			Inte	rconnect l	ine Corridor			
S1ACH001	Roadside Ditch	6.0	0.0	0,0	G,S,Co	Non-RPW (Ephemeral)	Low	Artificial

Interconnect line Corridor

\$1ACH001 - \$1ACH001 is a high-gradient roadside ditch that appears to flow only in response to rainfall events. The substrate is sand and gravel with extensive areas of rip-rap. There was no water in the channel at the time of the survey. It flows from north to south along a gravel road into a stormwater feature at the bottom of the hill outside of the survey corridor.

4.3 **General Habitats**

Two main habitat types were observed on the South Carolina portion of the project during the field survey: planted pine and commercial/industrial land (active quarry).

Planted pine generally consisted of loblolly pine (Pinus taeda) and Virginia pine (Pinus virginiana) in the overstory without much of an understory or herb layer, although blackberries (Rubus spp.) and running cedar (Lycopodium digitatum) were identified on the single tract of property owned by a private individual. This habitat type occurs over approximately 11 percent of the interconnect line survey corridor in South Carolina.

The portion of the proposed interconnect line after it crosses into South Carolina predominantly occurs on property managed as an active rock quarry. The majority of this area is either maintained grass slopes or gravel roads. This habitat type occurs over approximately 89 percent of the interconnect survey corridor in South Carolina.

4.4 **Protected Species**

No individual occurrences, populations, or evidence of activity of the protected species included in Table 3 were identified during field surveys. There is a slight potential for several species of protected plants to be present in the vicinity, but evaluation of the subject site suggests that substantial past disturbance has occurred, which reduces the potential for the protected species to be present.

Transient species, including birds and mammals, are potential users of the site habitat, at least seasonally. These species utilize a wide range of habitat. From the limited survey that was completed in this study, it is not possible to rule out the presence of these transitory or migratory species within the interconnect line survey corridor, but their transient nature makes it unlikely that they would be or remain present during the activity associated with construction.

⁽c) Based on National Hydrographic Dataset (USGS, 2000)); RPW = Relatively Permanent Waterway

4.5 Man-Made Features

Two man-made features were observed during the field survey of the interconnect line corridor (see locations on Figures 4 and 5). Both of these features are stormwater collection basins. Neither of these features had standing water in them at the time of the survey. Field survey datasheets and photographs are included in Appendix A and B, respectively.

4.6 Cultural Resources

During initial field surveys, the Old Shiloh Presbyterian Church Cemetery was located near the proposed Project route in Cleveland County, North Carolina, along the South Carolina state line. To further characterize this important cultural resource, a more extensive survey of the area was performed. A detailed analysis of results from the investigation is provided below. Based upon this information, the Alternative Route 1 was created to avoid impacts to this feature. In addition, Southern Power voluntarily met with the church wards of the cemetery and is offering to provide a protective fence around the cemetery to help protect the site from future impacts. Please refer to Appendix C for additional information.

On September 2, 2008, New South Associates conducted a ground penetrating radar (GPR) survey of a limited portion of the Old Shiloh Presbyterian Church Cemetery in Cleveland County, North Carolina, and Cherokee County, South Carolina. The survey had two major goals: first, to investigate the possibility of unmarked graves along the southern boundary of the cemetery; and second, to investigate an isolated grave west of the main cemetery (referred to as the Dover grave). The GPR survey covered the equivalent of approximately 361 square meters in the two areas. The actual area surveyed was larger, because multiple transects were extended beyond the established grids.

The Old Shiloh Presbyterian Church Cemetery is a prominent cemetery in the Cleveland County area, with several important figures buried there. Although a church was known to exist in the immediate vicinity at some point in the past, its original location is unknown, and there is no evidence of its presence today. The cemetery itself is located in a wooded area approximately 80 meters south of Elm Road (NC 2278), east of Grover, North Carolina. There are several mature trees scattered throughout the cemetery, although the grounds are well maintained with virtually no underbrush. The core area is bounded by a circular road that appears to have been there for decades. No exact count of graves is known, although it is estimated to be approximately 100, with an isolated grave located several tens of meters west of the main section, in a wooded area. Most of the graves in the main section are well marked and appear to be arranged in family plots. However, the overall condition of many individual markers is poor at best, and it is possible that several markers may have been displaced over time.

Results indicate the presence of two possible unmarked graves in the southern survey area that is also within the formal cemetery boundary. There is no evidence of unmarked graves south of the current boundary. GPR data for the Dover grave is inconclusive, with no obvious anomalies that might be interpreted as graves. Because of the age of this grave (the marker indicates a death date of 1788), it may no longer be detectable by GPR. Although the GPR data did not positively indicate a grave, after discussions with church wards, Southern Power elected to treat this spot as a potential grave site and avoid this area. A revised cemetery boundary was GPS-plotted to facilitate the preservation of the cemetery.

4.7 Socioeconomics

Population demographic information from the United States Census Bureau Fact Finder (http://factfinder.census.gov) was analyzed to compare the socioeconomic similarities and differences between the areas impacted by the three proposed routing alternates. Population demographics and economic status is similar between the three areas, with a slight economic advantage generally favoring the Cleveland County, NC (ZIP 28073) side of the state line. The proposed routing impacts three land owners, other than Southern Power, within South Carolina. These properties include a rock quarry, an existing power plant operation, and one family of willing landowners. None of the impacted properties are residential in nature.

Protected Species Potentially Present Along the Proposed CCGF 230-kV Bus Line in Cherokee County, South Carolina and Cleveland County, North Carolina

Common Name Scientific Nam		Scientific Name Federal State Status ^{a,b}		Potential to occur within the proposed right-of-way	
Cleveland County, North Carolina					
Dwarf-flowered heartleaf	Hexastylis naniflora	ī		Hexastylis naniflora is found on acidic sandy loam soils along bluffs and nearby slopes, hillsides and ravines, in boggy areas adjacent to creek heads and streams site conversion from woodlands to pasture. H. naniflora is found on moist to rather dry north-facing slopes of ravines in the Piedmont, usually in the oak-hickory-pine community type.	Not likely due to lack of habitat.
Gray's saxifrage	Saxifraga caroliniana	SC		Saxifraga caroliniana is found in rocky woods. S. caroliniana occurs in cool, shaded, rocky woods and rock ledges, rooted in the thin layer of organic matter and moss that forms on the surface of the rocks. Almost always in steep terrain and often in areas misted by spray from nearby waterfalls or in areas where water trickles down the rocky slopes.	Not likely due to lack of habitat.
Sweet pinesap	Monotropsis odorata	SC		Monotropsis odorata occurs in mixed deciduous woods.	Slight potential to occur.
Torrey's Mountain-mint	Pycnanthemum torrei	SC		Pycnathemum torrei is found in the mountains and in the Piedmont, in rich woods, and usually on rock such as gabbro or diabase. Some sites seem to have been maintained in the past as opened areas, probably by fire and other activities. (University of Minnesota Herbarium [MIN], Weakley 1994).	Not likely due to lack of habitat.

Protected Species Potentially Present Along the Proposed CCGF 230-kV Bus Line

in Cherokee County, South Carolina and Cleveland County, North Carolina

Common Name	Scientific Name	Federal Status ^{a,b}	State Status ^{a,b}	Habitat Requirement ^c	Potential to occur within the proposed right-of-way
Cherokee County, South Carolina		_			-
Dwarf-flowered heartleaf	Hexastylis naniflora	Т	Т	Hexastylis naniflora is found on acidic sandy loam soils along bluffs and nearby slopes, hillsides and ravines, in boggy areas adjacent to creek heads and streams site conversion from woodlands to pasture. H. naniflora is found on moist to rather dry north-facing slopes of ravines in the Piedmont, usually in the oak-hickory-pine community type.	Not likely due to lack of habitat.
Nodding onion	Allium cernuum		SC	Allium cemuum occurs in meadows and open woods where it is locally common.	Slight potential to occur in open areas.
Georgia Aster	Aster georgianus		SC	Aster georgianus is found in dry open woods, roadsides, and other openings. Probably a relict species of the post oak (Quercus stellata)-savanna communities that existed in the region prior to fire suppression and the eradication of large native grazing animals (Murdoock 2001).	Slight potential to occur.
Rough Sedge	Carex scabrata		sc	Carex scabrata occurs on seepage slopes and springheads in rich woods in mountainous regions of the Carolinas.	Not likely due to lack of habitat.
Smooth Sunflower	Helianthus laevigatus	-	sc	Helianthus laevigatus requires high light availability and generally occurs in open areas with shale, dolomite, limestone, or ultra-mafic, igneous substrates (Ludwig pers. comm. 1995). In North Carolina and South Carolina, all occurrences are in disturbed areas on slate derived soils in woodlands and on road embankments.	Not likely – local geology does not match habitat description

Protected Species Potentially Present Along the Proposed CCGF 230-kV Bus Line in Cherokee County, South Carolina and Cleveland County, North Carolina

Common Name	Scientific Name	Federal Status ^{a,b}	State Status ^{a,b}	Habitat Requirement ^c	Potential to occur within the proposed right-of-way
Ashy Hydrangea	Hydrangea cinerea		SC	Hydrangea cinerea occurs on shady ledges and cliffs.	Not likely, habitat does not appear to be present along proposed ROW.
Canada Moonseed	Menispermum canadense		SC	Menispermum canadense occurs in low woods.	Slight potential to occur.
Eastern Turkeybeard	Xerophyllum asphodeloides		sc	Xerophyllum asphodeloides is found in dry, sandy, oak-hickory woods, usually xeric in mountainous regions.	Not likely due to lack of habitat.
Southeastern Myotis	Myotis Austroriparius	-	sc	These bats generally use buildings and other structures, mines, and hollow trees (e.g., water tupelo, black gum, water hickory, bald cypress) for spring and summer roosts. The key characteristics for maternity sites are high humidity and constant warm temperatures. Foraging habitat is riparian floodplain forests or wooded wetlands with permanent open water nearby (MacGregor 1992, Gardner et al. 1992, Humphrey and Gore 1992). These bats may forage primarily over lakes, ponds, or slow-moving streams. Potential habitat includes standing snags and hollow trees.	Possible transient user of area, but not likely to use area for breeding or preferred foraging due to lack of quality habitat.

Protected Species Potentially Present Along the Proposed CCGF 230-kV Bus Line

in Cherokee County, South Carolina and Cleveland County, North Carolina

Common Name	Scientific Name	Federal Status ^{a,b}	State Status ^{a,b}	Habitat Requirement ^c	Potential to occur within the proposed right-of-way
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Notes:

- a/ Source: Table created using USFWS list of Federally Listed Species, North Carolina Wildlife Resources Commission Protected Wildlife Species in North Carolina, and South Carolina Department of Natural Resources Rare, Threatened, & Endangered Species Inventory by County.
- b/ Legal Status:

T = threatened. A taxon "likely to become endangered within the foreseeable future throughout all or a significant portion of its range."

SC = species of concern. A species under consideration for listing, for which there is insufficient information to support listing at this time.

Species with the status of Federal Threatened are legally protected under the US Endangered Species Act of 1973.

c/ Source: Additional details of Habitat Requirements were obtained from NatureServe Explorer (http://www.natureserve.org/explorer/) and the *Manual of the Vascular Flora of the Carolinas*. 1968. A.E. Radford, H.E. Ahles, C. R. Bell.

4-4

5.0 Conclusions

Based upon the analyses conducted, Alternative 1 effectively avoids and mitigates environmental and socioeconomic impacts for the construction and operation and maintenance of the proposed project through responsible route planning, and utilizing overhead construction methods. Much of the approximate 0.86 mile length will parallel an existing Duke Energy 230-kV transmission line on steel lattice towers with an existing, maintained 150-foot wide right-of-way. A portion of the line will be constructed near and over Vulcan' Material's Blacksburg Quarry, where rock mining operations are and historically have been conducted. The line and right-of-way are in a remote, unincorporated rural area and cross only three landowners. Placement of poles and spans between poles have been designed to avoid potential environmental impacts.

Two wetlands were identified during the field surveys. One ephemeral roadside ditch was identified along the proposed interconnect line corridor. These areas will be spanned by the proposed interconnect line, and no environmental impacts are anticipated.

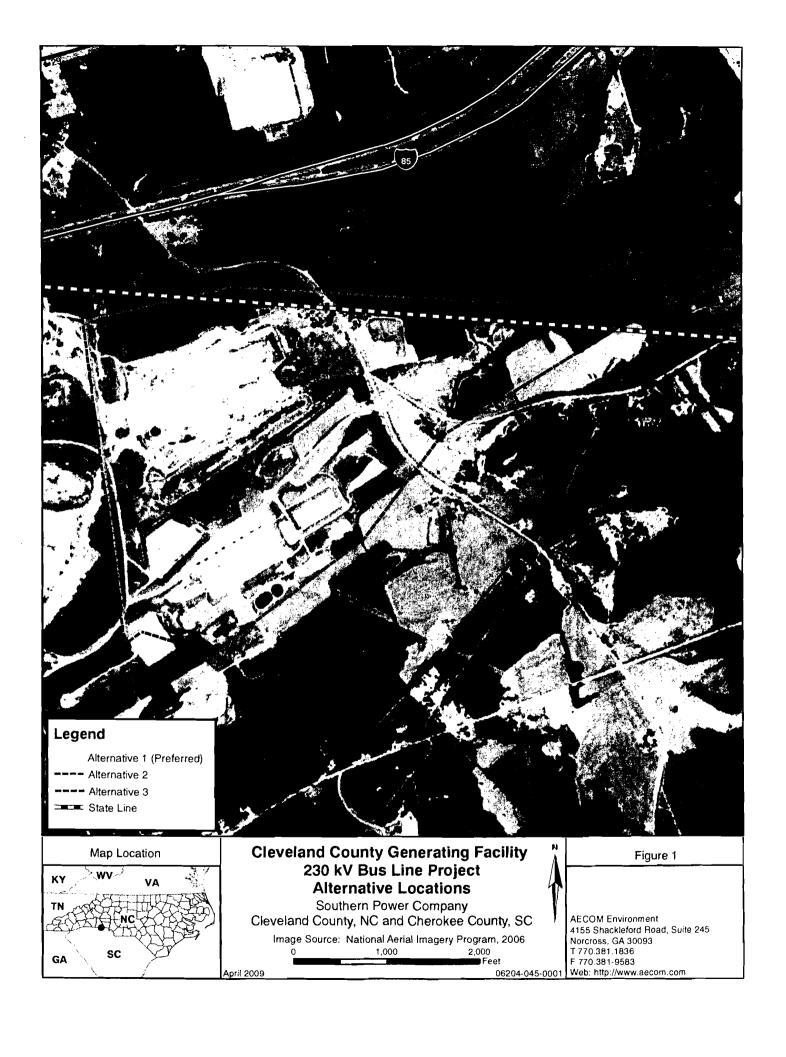
Two main habitat types were observed during the field survey: planted pine, and commercial/industrial land (active quarry). No individual occurrences, populations, or evidence of activity of protected species were identified during field surveys. Two man-made features were observed during the field survey of the interconnect line corridor; both are stormwater collection basins.

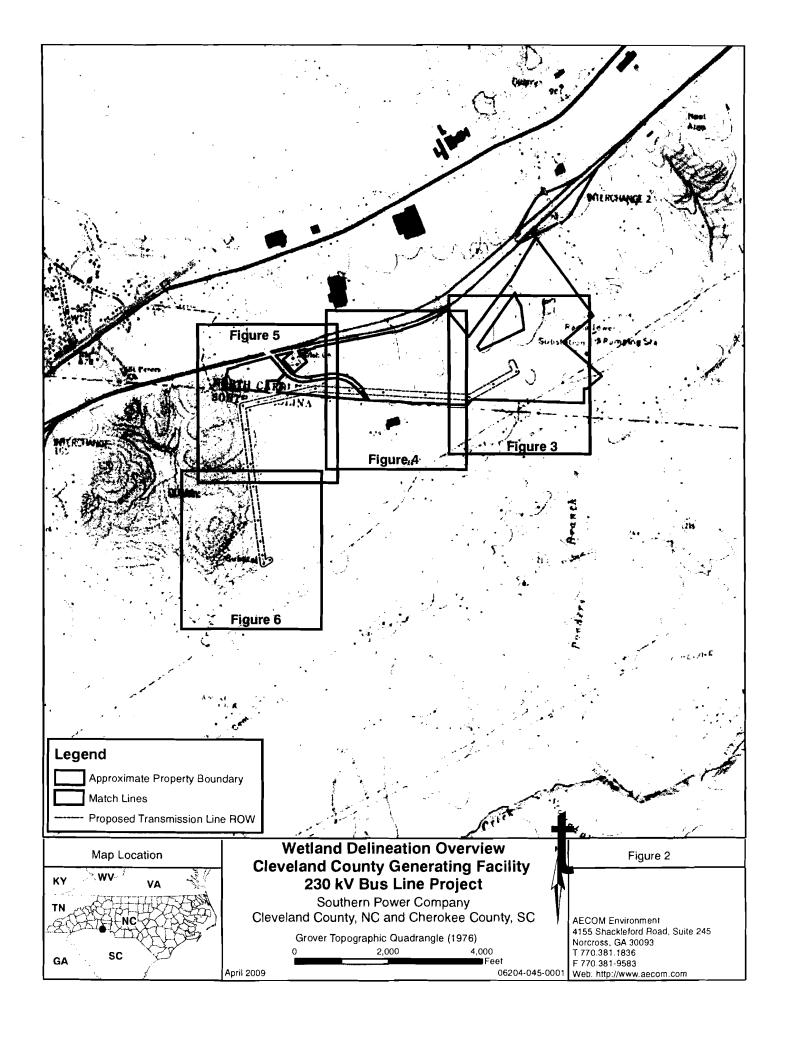
Cultural resource surveys were conducted September 28, 2008; to identify and assess the possibility of graves in the vicinity of the proposed Project route. Based on the survey, there were no graves identified outside of the existing cemetery boundary in the vicinity of the proposed Project route. In addition, Southern Power has offered to enhance protection for the Old Shiloh Presbyterian Church cemetery by installing a protective fence around the cemetery.

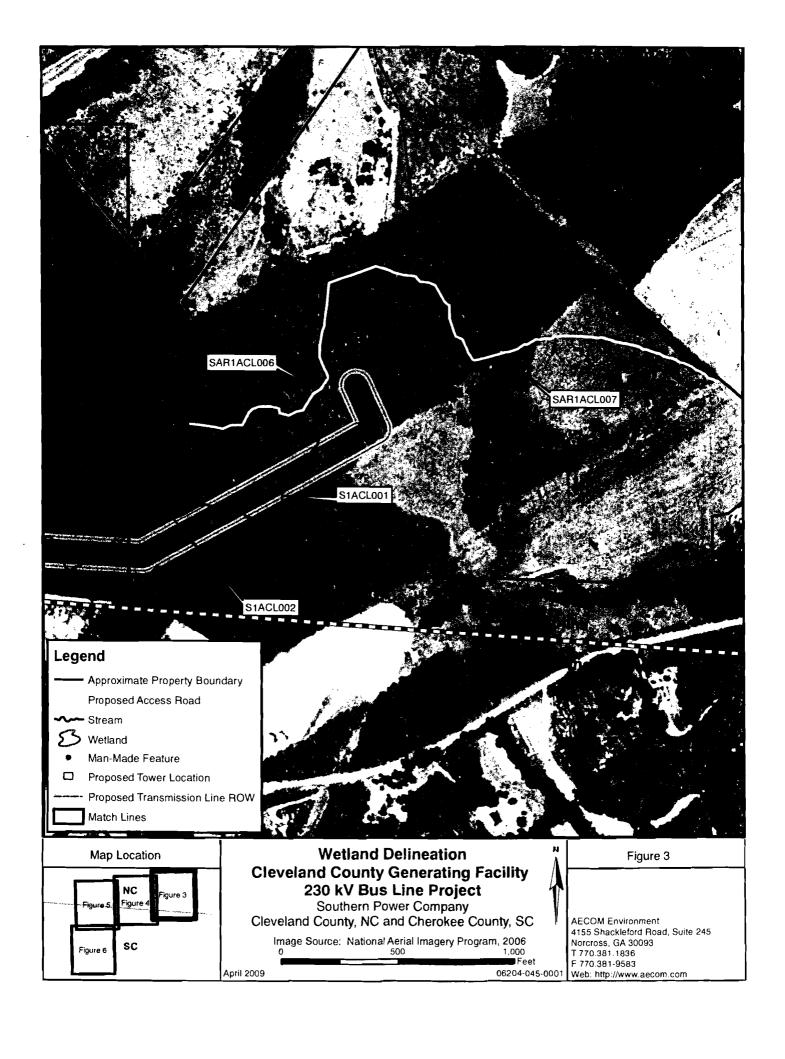
6.0 References

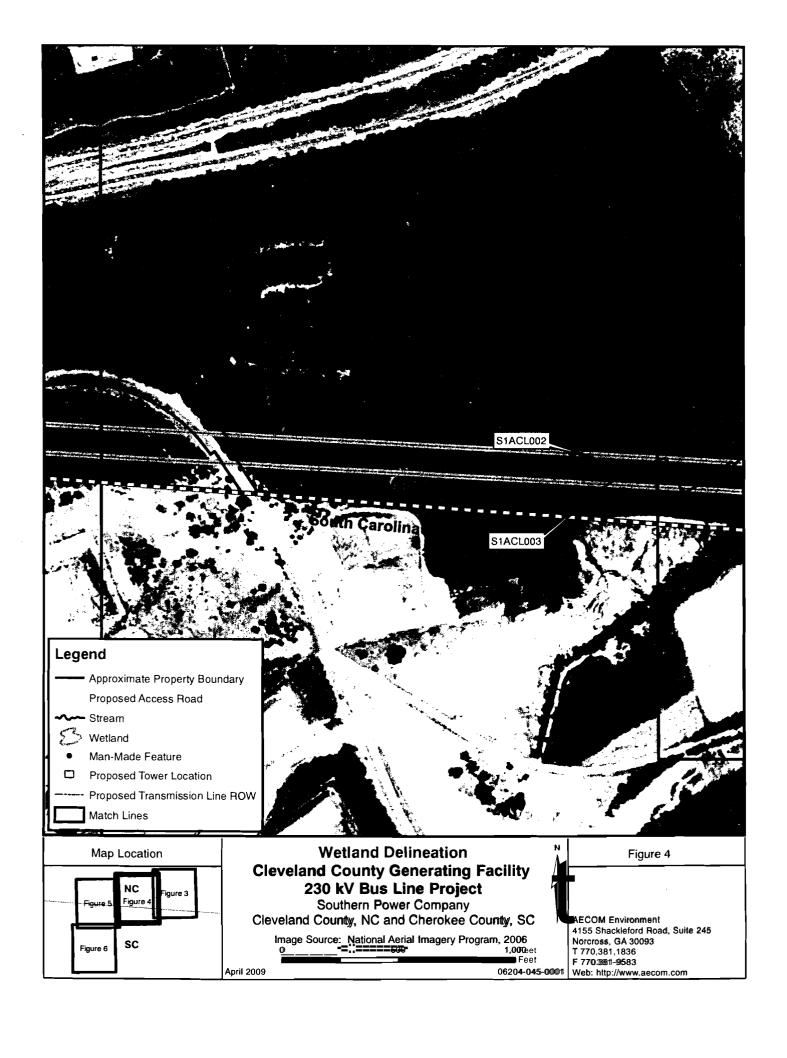
- Environmental Laboratory. 1987. Corps of Engineers Wetland Delineation Manual, Technical Report Y-87-1 US Army Engineer Waterway Experiment Station, Vicksburg, MS.
- Munsell Color Chart. 2000. Munsell Soil Color Charts, 2000 Revised Edition.
- North Carolina Natural Heritage Program Element Occurrence Database. 2009. Website: http://www.ncnhp.org/Pages/heritagedata.html
- South Carolina Department of Natural Resources Rare, Threatened, & Endangered Species Inventory by County. 2009. Website: https://www.dnr.sc.gov/pls/heritage/county_species.select_county_map
- United States Army Corps of Engineers. 2006. Laws regulating the Corps of Engineers Regulatory Program. Website: http://www.spk.usace.army.mil/cespk-co/regulatory/regs/start.html
- United States Geological Survey, Environmental Protection Agericy. 2000. The National Hydrography Dataset. Website: http://rihd.usgs.gov/chapter1/index.html
- United States Fish and Wildlife Service. 2007. Lists of threatened and endangered species. Website: http://www.fws.gov/

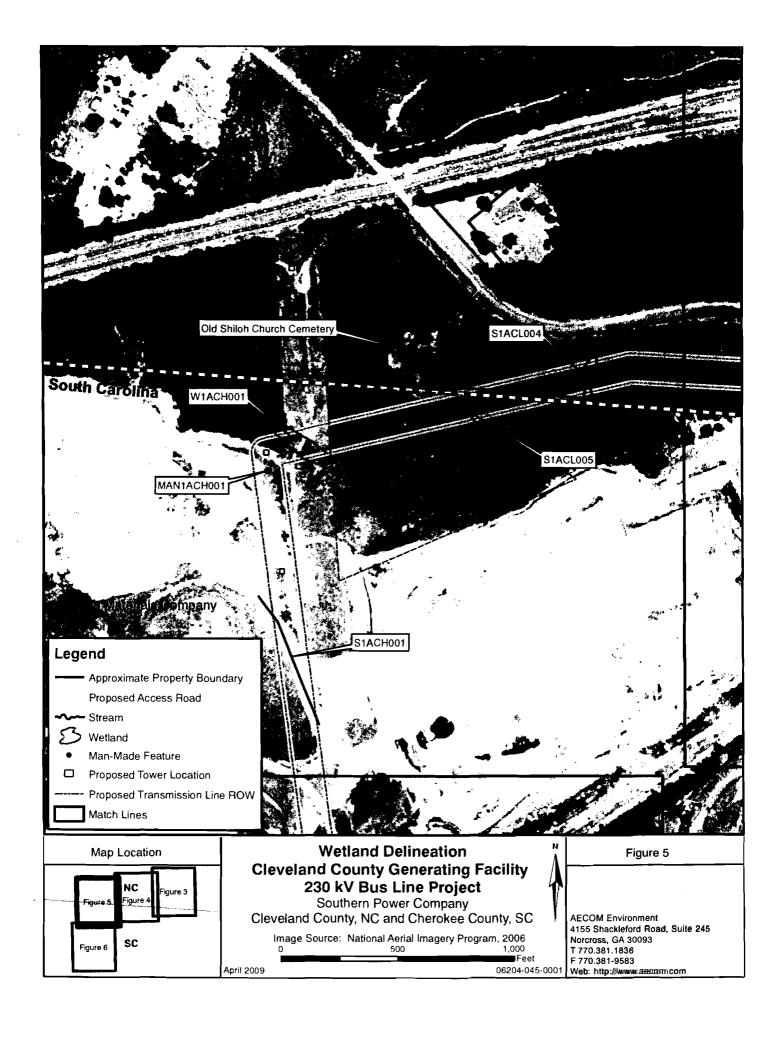
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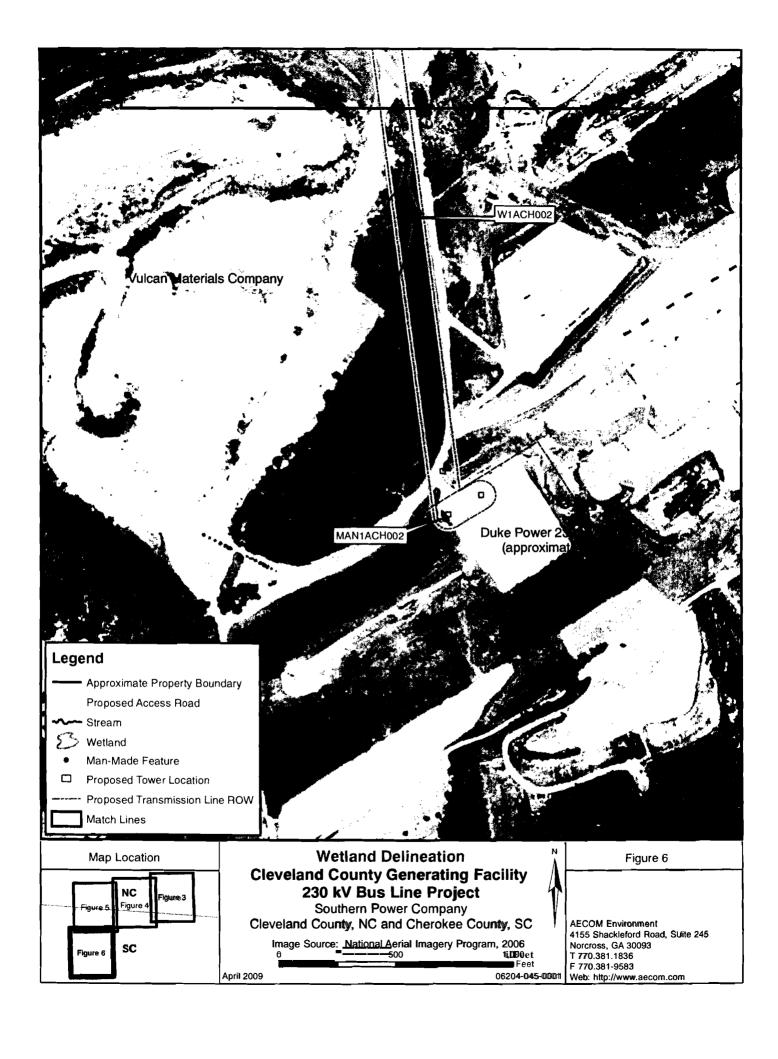












Appendix A

Datasheets

WE	ETLAND DELINEAT	ION DA	1A FORM (198				
enterline Re-Route Access R	Road Warehouse Site Up	pland Data		Wetlar ciated Street	nd ID No.:(am ID No.:	ORIAC	H002
Date: 3 -18-09 Client/Pro	oject Name & No.: Sow	hein			Milepost:		
Investigators: SAC/DV	State/County/Mun	icinality:	C/ Cherc	1400	Quad Name:	Grove	اعد
Logbook No.: Logbook F	10 101	ock/Lot/Trac	7		Picture No.:		
				T			
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1. Louicerà Japon	sica H	FACT	- 10 4.				ļ
5. Quercus falca	منف، ا	PACU-	- 5 5.				
· Carya glabra		*ACM	5 6.				
7. Liguraneoux	stypacitions S	TAL A	- 5 7. - 5 8				
8. Alljum Chadden	** F	PPCU	<u>~ 5 8. </u>				
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mary Wetland Indicators (circle the	·····		Secondary Wetland I	Indicators (2 or n	nore required) (circle	those that apply):
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Saturated in Upper 12 Inches	Water Marks		Water-Stained Leaves Other (Explain in Remarks)				
Drift Unes	Drainage Patterns in Wetland	ts	Local Soil Sulvey Date	a			
Remarks: NO We	tland hyd	drolo	194 Pres	<i>x</i> nt			
Map Unit Name (Series and Phase):	Car Makelow	Drainag	je Class:	train	1	AND DESCRIPTION OF THE PARTY OF	
Taxonomy (Subgroup):	Siltyllay 100) In	bservations Confirm Mag		<u> </u>		
Profits Constitutions		FIBIO OI	paervations Committe Mar	phen Type:			
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3-161	54R 4/6		,	()	The cla		
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		†					
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Remarks: hydric (soils not	P	resent				
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ydric Soils Present?	Yes No		le This Wetland Adia	cent to or Abutti	ng an Associated 8	tream? Yes h	vo

WETLAND DELINEATION DATA FORM (1987 COE METHODOLOGY) (OR ACHEOT

				Wetland <u>I</u> D No.:	MIACH	2001
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If not abuilting a stream, is there a surface co	nnection between this V	Willand and a stream?	Yes No Wa	aterbody ID No.:		
Flow between Weiland and Stream la:	No Flow	Pêrennial	Intermittent	Ephemeral	Subsurface Flow?	Yes No
Surface flow between Wellendland Street	<u> 16:</u>	Discrete	Conlined	Discrete & Confined	Overland Sheetflow	Not Present
Surface flow between Wetland and Street	ls: No Flow	From Wetle	and to Waterbody	From Waterbody to We	atland To/From Wetle	and to Waterbody
Other connection with Stream?	None	Ecological	Separated by berm	/barrier? Yes No	<u> </u>	
Drawing		*.************************************			3.000	VI CONTRACTOR
Please include: Directional & North Arro	w, Centerline, Lengt	h of feature, Distanc	es from Centerline,	Photo locations, and	Survey corridor	
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Description of Wetland Cross in a nivest land Wetland (Quality Griteria)

Wetland Method 1: Can be used in wetlands whet kills are dry anough at the time of constitution to Surviolit statement. This crossing method requires topacit segregation, and requires to special **Blabilization techniques.**

Wetland Method 2: Conventional Wetland Constituction will be used for excessing wetlands with saturated Soits otherwise unable to Supplicit matriaries constituction exhibitment. Because the soits are

satisfated, there is a need to Stabilize the Power during communication.

Wettend Method 3: PushPowl Wetland Construction will be used in large wettend areas writers sufficient fiveneous is besent for the attinuable Dibeling in itraditional, and it called elevation over the length of the push/pull takes will not require damming to maintain adequate water levels for floatation of the pipe.

HIGH QUALITY WETLAND: no indication of stress or disturbance in wetland or adjacent area - divacte and meture vegetation types - thydrologic and soli indicators are charactedestic of the

specific community type - provides suitable hitbitiat for wildfile - high quality perennial streams are offer observed

MODERATE QUALITY WETLAND: mild to moderate disturbences have caused alterations in immediately adjacentiaties - slightly aftered natixal vegetation, hydrology and/ or soil

MODERATE QUALITY WETUAND: min to moderate destinations in immediately adjacent areas - signify attered natural vegetation, nycroogy and or soil viracteristics - provides suitable habitat for wildfife and vegetation - associated performance or intermittent streams are of relatively good quality and area that significant changes to vegetation, solts, or hydrology/- hydroperiod alterations, if present, have dividity affected plant species - soils currently composition has changed - noticeable stress or death of plant species - soils until be not related by the present of t significantly disturbed

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	c Page No.:	6-17 B	lock/Lot/Tract	No.:		Picture No.:		
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nary Wetland Indicators (circle				Seconda	ry Wetland Indicate	ors (2 or more required) (cir	cle those that appl	y):
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Saturated in Upper 12 Inches	Water Mark	-		Water-S	tained Leaves	Other (Explain in Remark	(a:
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Profile Description: Depth (Inches) Horizon	Matrix Color		Mottle			Texture, Concretions, St	nictive etc	
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land Hydrology Present? Jric Soils Present?	Yes Yes	No			In isolated Wetland	? or Abutting an Associate	Yes No	<u></u>
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WETLAND DELINEATION DATA FORM (1987 COE METHODOLOGY)

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If not abutting a stream, is there a surface con	nection between this	wettand and a stream?	Yes No W	aterbody ID No.:		
Flow between Wetland and Stream is:	No Flow	Perennial	Intermitteht	Ephemeral	Subsurface Flow?	Yes No
Surface flow between Wetland and Stream	ia:	Discrete	Confined	Discrete & Contined	Overtand Sheetflow	Not Present
Surface flow between Wetland and Stream	le: No Flow	From We	tland to Waterbody	From Waterbody to We	tland Cto/From Wetle	and to Waterbody
Other connection with Stream?	None	Ecological	Separated by berm	/barrier? Yes (No)		
Drawing Please include: Directional & North Arro	w, Center line , Leng	th of feature, Distan	ces from Centerline,	Photo Locations, and	Survey corridor	
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Wattland Method 3: Pushi/Pull Wetland Construction will be used in <u>large wetland@wess Where Sufficialt Hydrology is Bresent limit the pipeline in the pipeline in the training to maintain adequate will reverse for limitation of the pipe.</u>

HIGH QUALITY WETLAND: no indication of stress or disturbance in wetland or adjacent area – diverse and mature vegetation types – hydrologic and solitimiticators are characteristic of line specific community type – provides suitable babitat for wildfile – high qualify pelithritifilitiesms are often observed

specific community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community type - provides suitable habitat for wildliffe - high quarity personal resolution of the community resolution resolution of the community resolution resoluti

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Hydrophytic Veget		(Y68 ⁷ )	No			pling Point Wi		and?	(Yes	No Ala		
	detiand Hydrology Present?											
riydric Soils Prese	H (	/Y 678	No		IS THE WE	109221DN Pile	in or Vont	IIG BIT ASSOCIAT	AN SEASON	Yes No	<u>'</u>	

#### WETLAND DELINEATION DATA FORM (1987 COE METHODOLOGY)

Wetland ID No.: WIACHOOZ Client/Project Name & No.: Southern Milepost: Yes Waterbody ID No.: If not abutting a stream, is there a surface connection between this wettand and a stream? Flow between Wetland and Stream is: No Flow Perennial Intermittent **Ephegneral** Subsurface Flow? Overland Sheetsown Surface flow between Wetland and Stream is: (Discrete & Contined) Discrete Contined Not Present Surface flow between Wetland and Stream is: From Wetland to Waterbody From Waterbody to Wetland To/From Wetland to Waterbody Other connection with Stream? Separated by berm/barrier? Yes None **Ecological** prawing it is a second of the Please include: Directional & North Arrow, Centerline, Length of feature, Distances from Centerline, Photo Locations, and Survey corridor observed PSE thomsitions to PEN DE thigh of proposed Row unters from NE through culvert no Definedo Wettland Method 1: Can be used in wetlands where solls are dry enough at the time of construction to support equipment. This crossing method requires topsoil segregation, and requires no special stabilization techniques.

Wetland Method 2: Conventional Wetland Construction will be used for crossing wetlands with saturated soils otherwise unable to support maintine construction equipment. Because the soils are saturated, there is a need to stabilize the POW during construction.

Wetland Method 3: Push/Pull Wetland Construction will be used in large wetland areas where sufficient hydrology is present for ficating the pipeline in the length and grade elevation over the length

of the push/pull area will not require damming to maintain adequate water levels for floatation of the pipe.

HIGH QUALITY WETLAND: no Indication of stress or distintisance in wetland or Midecent area - diverse and malure vegetation types - hydrologic 8thd soil indicators are distinctions are distinctions. specific community type - provides suitable habitat for wildlife - Inigh quelfity pereinnial streams aid often observed MODERATE QUALITY WETLAND: mild to moderate distuitations have calified alterations in immediately adjacent altities - slightly littered natural vegetation, hydrology and/ or soil

*Arracieristics - provides suitable habitat for wildlife and vegetation - associated perennial or intermittent Birearrits are of lititatively good quality and aren't significantly disturbed

W QUALITY WETLAND: severe disturbances have caused significant changes to vegetation, soits, or hydrology - hydroperiod alterations, if present, have directly affected plant species 
community composition has changed - noticeable stress or death of plant species - soil subsidence may have occurring in a had with decitiased hydroperiod; mectanical alteration of plant species of soils - grazing from investock - channelization of stream courses or ditching - little suitable habitistifor wildlife and vegetation - associated perennial or intermittent Bireams significantly disturbed

facing here:

#### WATERBODY

ENSR | AECOM

"aterbody Name: UT to Ponders Branch Waterbody ID No.: Access Road Centerline Re-Route Warehouse Site Other: **Associated Wetland No.:** Date: 3 Client/Project Name & No.: South Milepost: State/County/Municipality: Quad Name: Investigators Groven Block/Lot/Tract No .: Logbook No.: Logbook Page No.: 4-5 Picture No.: PHYSICAL ATTRIBUTES Waterbody Sketch Plan Please include: Directional & North Arrow, Centerline, Length of feature, Distances from Centerline, Photo Locations, and Survey corridor NMH SIACLOOI Angle of Crossing at Centerline: Waterbody Type Lake Pond **Borrow Pit** River Ag. Ditch Other: Stream Flow Fast Slow Moderate **Very Slow** None SSE Perennial (Flows Intermittent/Seasonal Direction: Flow type Ephemeral (Flows only in months annually) (Flows <3 months response to rainfall) Number of Annual Flow Events annually) **OHWM** Indicator Clear natural line on bank Shelving Wrested vegetation Scour Water Staining Bent, matted or missing vegetation Soil character chappes Abrupt plant community change Wrack Ilne Litter and debris Sinuosity Straight Meandering Subsurface Flow? Yes No Unknown 3-8 24-36 Stream Depth (In.) 0-3 12-18 18-24 48-60 6-12 36-48 60+ Stream Width (ft.) Top of Bank (at crossing location): Water Surface (at crossing location): Bank Height (ft.) 4.6 Læft 0.2 2-4 6-8 8+ (looking downstream else give direction you are **43** Right 0-2 2-4 6-8 8+ facility here: 9ank Slope (°) (+O) Leeft 40-60 0-20 20-40 60-80 )oking downstream else Right 0-20 20-40 40-60 60.80 give direction you are

SIACLOGI

Jate: 3-17-09	Client/Project Name	ano: Southern			Milepost:			
QUALITATIVE A	TTRIBUTES							
Water Appearance	Clear	Slightly Turbid	Turbid		Very Turbid	Color:		
	Floating algal mats	Obvious surface scum	Sheen	on surface ,	Greenish color	Other:		
Stream Substrate %	Bedrock	Gravel_ICO_	Sand	Silt/Clay	Organic			
Aquatic Habitats	Sand Bar	Graver Bay	Mud Ba	ır ·	Gravel Riffles	Deep Pools		
Undercut Banks	Overhanging trees/shrubs	In-stream emergent plants Percent Cover	plants	rn submerged t Cover	Bank root system	Fringing Wetlands		
Aquatic Organisma	Waterfowl	Fish (adult)	Fish (ju		Frogs	Turties		
Observed	Snakes	Other:	1 02	,	N. Was	1 7 2 1 3 2		
v	Invertebrates:	Intolerant	Facultat	tive	Tolerant	None		
Riparlan Zone	<u> </u>	zone from edge of active cha	nnel out o	nto flood plain:	100+ (h)			
	Circle vegetative layers:	trees shrubs berbs						
	☐ Significant bare areas	s within riparian zone						
Evidence of non-buffered concentrated flows								
Tributary is	Natural							
Channel Condition	Channelization/Braiding	Unnatural straightening	Downo	zutting	Dikes/Berms	excessive bank erosio		
7Isturbances	Livestock access to r	parian zone		Manure in	stream or on banks			
	☐ Waste discharge pipe	es present		12 Other:	hone			
TIE ODEOLEO / OLUTAD	L LIADITAT			Habit	at ID No.;			
T/E SPECIES / SUITAB	LE NABITAT			1 Killion Co	at ID No			
No	e observed	ı						
Comments (e.g. pipeline	e crossing angle, construction	constraints, erosion potential,	, existing d	listurbances, and	meanders)			
Small.	deeply make	d perennia	٧ ،	tream	_			
STREAM QUALITY (inc	licate) D H	ligh <del>Q:</del>	D _{Mo}			•		

cover types available; diverse and stable aquatic habitat; no disturbance by livestock or man; intolerant macroinventebrates present.

Moderate Quality: Altered chimiliel evidenced by rip rap and/or channelization; dikes/levees restrict flood plain width; halfulful vegetanion extends 1/BJ 1/2 of the active channel width on each side; filtering function of riparian vegetation only moderately compromised; banks moderately unstable (outside bends actively eroding with few fallen trees); considerable water cloudiness, submerged objects concred with green film; moderate odor; minor barriers to fish movement; 4-3 fish cover types available; fair aquatic habitat; minimum disturbance by livestock or man; Pacultative macroinvertebrates present.

Low Quality: Channel is actively downcutting or widehing; rip rap and channelization excessive; flood plain restricted by diken/levees; natural vegetation less than 1/3 of the ctive channel width on each side; lack of regeneration; fillering firitition exercely compromised; Bankis unistable (inside and outside bends actively eroding with assuremous allen trees); water very turbid to muddy; obvious polluitibiti (algal mats, surface scum, surface sheen); heavy odor; green color to water; severe barriers to fish inovenient; 2-0 fish cover types available; little to no aquatic habitat; severe disturbance by livestock or main; tolerant or no mainsimvertationates present.

# ENSR AECOM

### WATERBODY

Vaterbody Name:	T to	Yonde	cs Bro	rnch		Naterbody I	ID No.:	_5	IAC	2002
Centerline Re-Re	oute Ad	cess Road	Wareho	use Site	Other:	Associated \	Wetland No	L.		
Date: 3-17-0	Client	/Project Na	me & No.: (	Souther			Milepost			
Investigators:	15M		State/County	/Municipalit		leveland	./ Quad Na	ame:	<u></u>	
		ا age No.:(ہ		ot/Tract No.		Picture			500	ver
PHYSICAL ATTRIB		Ψ.	<u>u</u>							
										<del></del>
Waterbody Sketch Pl Please include: Directi		rth Arrow. (	Centerline, L	enoth of fea	ture. Distar	nces from Co	enterline. Ph	oto Lo	catio	ns. and
Survey corridor		· · · · · · · · · · · · · · · · · · ·		. (			,د			,
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Waterhady Trees	Loke	Bood	Borrow Oli	Dhee:			Ssing at Cer	iteriin	<del></del>	
Waterbody Type Stream Flow	Lake Fast	Pond	Moderate	River	Slow	Ag. Ditch	Other: Very Slow			None
Flow type	Perennial	(Flows >3	Intermittent/S	easonal		(Flows only in	Direction:			
'	months an	nually)	(Flows <3 mo annually)	nths	response to	rainfalf)	Number of An	nual Flo	w Eve	ints
OHWM indicator	Cloa	r natural line		Shelving	Wrested	vegetation	Scour	·	Water	Staining
Bent, matted or missing v	egetation	Soil charac	eter changes	Abrupt p	lant communi	ty change	Wrack line	I	Litter a	nd debris
Sinuosity	Str	alght	Mean	derina	Subsurf	ace Flow?	Yes	No	)	Unknown
Stream Depth (In.)	0-3	3-6	6-12	2-18	18-24	24-36	36-48	48-€	60	60+
Stream Width (ft.)	Top of Bar	nk (at crossing	location):	۶'	Water Surfa	ce (at crossing	location): 8	(	041	WH 8'_
Bank Height (ft.) (looking downstream else	Left	0-2	Ę.	4)	4	l-6	6-8			8+
give direction you are	Right	0-2	(2-		4	-6	6-8			8+
facing here:) Panik Slope (*)	Left	0-20	20-		40		60-80			(80+)
oking downstream else	Right	0-20	20-			+60	60-80		ļ	(80+)
ve direction you are facing here:)	, "y",	V-20					00.60			

ENSR AECOM
SIACLOGZ

Waterbody ID No.:

Water Appearance	Clear	Slightly Turble	Turbld		Viery/Tiurtyld	Color:
	Floating algal mats	Obvious surface scum	Sheen	on surface	Greenish Color	Other:
Stream Substrate %	Bedrock: k(U)	Gravel LDD	Sandd	3 <b>Q</b> ∟	Sitt/Clay	Organic
quatic Habitats	Sand Bay	Gravel Bar	Mud Ba	r	Gravel Riffles	Deep Pools
ndercut Banks	Overhanging treas/sihrubs	in-stream emergent plants Percent Cover	plants	m submarged Cover	Bank root systems	Fringing Wetlands
Aquatic Organisms Observed	Waterflowl Snakes	Fish (adult) Other:	Fish (JA	venis)	Frogs	Turtles
	Invertebrates:	Intoleran	Facultat	ive	<b>Tolerant</b>	Nene
		within riparian zone ared concentrated flows		<del></del>		
Tributary le	(atural)	Artificial (Man-Made)	Manipu	ulated (Explain be	elow) (;	Shifting / Unstabl
Channel Condition	Channelization/Braiding	Unnatural straightening	Downe	utting	Dikes/Berms	Excessive bank erosic
Disturbances	Uvestock access to ri	parlan zone		Manure in	stream or on banks	
	Waste discharge pipe	es present		Other:	hone	
/E SPECIES / SUITAB	LE HABITAT			Habit	at ID No.:	
rone 	observed					
<b>Comments</b> (e.g. pipelin	e crossing angle, construction	constitutions, erosion potentia	ıl, existing d	isturbances, and	meanders)	
	he sized q					
Some an	has byte	which is the	Norws	RON	centra	<u>ا</u>
SECTION	nas white	wisher hill	و محم			

channel width to each side; filtering function of riparian vegetation only moderately compromised; banks moderately libitable (outside bends actively eroding with few fallow

trees); considerable water cloudiness, submerged objects covered with green film; moderate odor; minor barriers to fish inovertient; 4-3 fish cover types available; fair aquatic habitat; minimum disturbance by livestock or man; Facultative Habitation vertebrates present.

Low Quality: Channel is actively downcutting or wideliling; rip rap lind channelization excessive; flood plain restricted by dikes/lievera; natural vegetation less than 1/3 of the active channel width on each side; lack of regeneration; filtering function severely compromised; Banks initiable (inside and outside bends actively eroding with numerous fallen trees); water very turbid to muddy; obvious pollutants (algal mats, surface scum, surface sheen); heavy odds; green color to water; severe barriers to fish movement; 2-0 fish cover types available; little to no aquatic habitat; severe disturbance by livestock or man; tolerant or no macroinvertebrates present.

# ENSR AECOM

#### **WATERBODY**

Waterbody Name:	LT to	tond	ers B	ranch	<del></del>	Waterbody I	D No.:	SIA	tCL	.003
Centerline Re-R	oute A	ccess Road	l Wareho	use Site	Other:	Associated '	Wetland No	. <b>:</b>		
Date: 3-17-00	Client	/Project Na	me & No.: (	Souther		<u> </u>	Milepost			
Investigators: TA	0/500		State/County			Levelona	1 Quad Na	ame:	A.	0.10 -
<u> </u>	ogbook P	age No.∕⊊.		.ot/Tract No.	<u> </u>	Picture		13	OY	over
		<u> </u>	1 Biodiaz			7 10,010	110 ( \	12		
PHYSICAL ATTRIB					_			<u>.                                    </u>		
Waterbody Sketch P Please include: Directi		orth Arrow (	^antarline I	ength of fee	tura Dieta	nces from C	entarline Ph	oto I o	catio	ne and
Survey corridor	onal a 140	atii Ailow, t	Jones IIIe, L		iture, Diste	1.00 1.00	51 NOTHITO, 1 TO	Olo Lo	catio	ns, and
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				'						
				(	A	ingle of Cros	sing at Cer	nterline	e:	
Waterbody Type	Lake	Pond	Borrow Pit	River	(Stream)	Ag. Ditch	Other:	<del>-</del>		
Stream Flow	Fast	-	Moderate		(Slow)		Very Slow			None
Flow type		(Flows ) 3	Intermittent/S		Ephemeral	(Flows only in	Direction:			-
	months an	inuality	(Flows <3 mo annually)	onins	response to	o raintan)	Number of Ar	nnual Fk	w Eve	ents
OHWM Indicator	Clea	ır natural ilne	on bank	Shelving	Wrested	vegetation	Scour	. (	Water	Staining
Bent, matted or missing v	egetation	Soll charac	cter changes	Abrupt p	lant commun	ity change	Wrack line		itter a	nd debris
Sinuosity	Str	alght	Mean	dering	Subsur	face Flow?	Yes	No	,	Unknown
Stream Depth (In.)	0-3	(3-6)	6-12	12-18	18-24	24-36	36-48	48-6	30	60+
Stream Width (ft.)	Top of Ba	nk (at crossing	location):	6	Water Surf	ace (at crossing	location):	51	Ott	WM 2'
Bank Height (ft.)	Left	0-2	2-	-4	-	4-6	6-8			8+
(looking downstream else give direction you are	Right	0-2		-4	······································	4-6	6-8			8+
facing here:)								_		<u></u>
* Bank Slope (°) ooking downstream else	Left	0-20	<del></del>	-40	\ \ <u>\</u>	0-66	60-80			80+
give direction you are facing here;)	Right	0-20	20	-40	4	0-60		AC		(80+)

Jate: 3-17-00	Cllent/Project Name	& No.: Souther	<u> </u>		Milepost:	
QUALITATIVE A	TTRIBUTES					<u> </u>
Water Appearance	Clear	(Slightly, Turbid)	Turbid	·	Very Turbid	Color:
	Floating algal mats	Obvious sustance scum	Sheen	on surface	Greenish color	,Other:
Stream Substrate %	Bedrock	Gravel (a)	Sand_	<del> </del>	Silt(Clay) 40	Organic
Aquatic Habitate	Sand Bar	Gravel Bar	Mud Ba	ur	Gravel Riffles	Deep Pools
Undercut Banks	Overhanging trees/shrubs					
Aquatic Organisms						
Observed	Snakes	Other:	1	•	1 5	1
	Invertebrates:	Intolerant	Facultat	tive	Tolerant	None
Riparian Zone	Width of natural vegetation	zone from edge of active ch	annel out o	nto flood plain:	(m)	
	Circle vegetative layers: (t				-	
	Significant bare areas	within riparian zone				
	_	ered concentrated flows				
Tributary Is	Naturals	Artificial (Man-Made)	Manip	ulated (Explain be	elaw)	Stelole ' Unstable
Channel Condition	Channelization/Braiding	Unnatural straightening	Downo	cutting	Dikes/Berms	excessive bank erosion
'lsturbances	Lilwestock access to ri	parian zone		Manure in	stream or on banks	
	Waste discharge pipe	s present		<b>⊠</b> Other: <b>/</b> /.	ore.	
TIE SPECIES / SUITAB	LE HABITAT			Habit	at ID No.:	
non.	e observed			<u> </u>		
Comments (e.g. pipelin	e crossing angle, construction	constraints, erosion potentia	l, existing d	listurbances, and	meanders)	
	perennial 8 Qt for shor H BC ROW (		rowlly.	ets SI	A CLOD) ; +0 m	temite
STREAM QUALITY (In	dicate)	ligh ——S>	(D) Mo	derate	Q] Low	
any dilkes/levies are set bac protected by roots that exte cover types available; dive	annel (no structures or dikes; no e ek to provide access to adequate f and to the base-flow elevation; we ree and stable aloud that; no debagast stidenand by its fine	lood plain; natural vegetation ex iter clear to tea-colored; no barri disturbance by livestotk or man	tends at leas iers to fish n ; intellement :	st one or two active novement (seasonal macroinvertebriites	channel widths on each s water withdrawals prever present	side; banks stable and nt movement); many fish

habitat; minimum disturbance by livestock or man; Pacultative macroinvertebrates present 3 ow Quality: Channel is actively downcutting or widening; rip rap and channelization excessive; filood plain restricted by dikes/levees; natural vegetation less than 1/13 of the tive channel width on each side; lack of regeneration; filtering function severely compromised; Banks unstable (inside and outside bends actively eroding with manualismallen trees); water very turbid to muddy; obvious pollutants (algal mats, surface seum, surface sheen); heavy odor; green color to water; severe barriers to fish movement; 2-0 fish cover types available; little to no aquatic habitat; severe disturbance by livestock or man; tolerant or no macroinvertebrates present.

channel width on each side; filtering function of riparian vegetation only moderately compromised; banks moderately unstable (outside bends actively enoding with few fallen trees); considerable water cloudiness, submerged objects covered with green film; moderate odor; minor barriers to fish movement; 4-3 fish cover types available; fair aquatic

# ENSR AECOM

#### WATERBODY

"aterbody Name:	<u>ui</u>		•		W	aterbody I	D No.:	<b>57</b> (4)	<del>*************************************</del>	1000 H
Centerline Re-Re	oute A	ccess Road	l Wareho	use Site	Other:	sociated \	Vetland No.	•		
Date: 3 = 14 - 80	Client	/Project Na		Progres	S		Milepost:			
Investigators: KA	1-TM		State/County	/Municipalit	y: NC (IC)	restitas	Quad Na	me: ¿	ŠF O	Wes.
Logbook No.: \ L	<u> </u>		Block/L			Picture		Ę,		<del></del>
PHYSICAL ATTRIB	UTES		,							
Waterbody Sketch Pl										
Please include: Directi Survey corridor	onal & No	rth Arrow, (	Centerline, L	ength of fea	iture, Distanc	ces from Ce	enterline, Ph	oto Lo	cation	ns, and
		Af'r	<b>&gt;&gt;</b>							
		g. 4 1 2 4 1	· ··	<u> </u>	SIACIB	184 Acr				
			14 10	177 114 1405		ล	I JAN			
				( ;	Ang	gle of Cros	sing at Cen	terlim	e:	
Waterbody Type	lanke	Pond	Borrow Pit	River	(Stream) A	g. Ditch	Other:			
Stream Rlow	East		Moderate		Slow		Very Slow	,		None
Flow type	Perennial months an	(Flows > 8 nually)	Intermittent/S (Flows <3 mo annually)		Ephemeral (Fi response to re		Number of An		w Eve	nts
OHWM/Indicator	Clea	r natural lime	on bank	(Shelving)	Wrested ve	egetation	Scour		Water	Staining
Bent, matted or missing v	egetation	Coll chases	ter changes	Abrupt p	lant community	change	Wrack line	4	itter a	nd debits
Sinuosity	Str	aight	Mean	dering	Subsurfac	e Flow?	Yes	No	,	Unknown
Stream Depth (in.)	0-3	(3-6)	., 6-12	12-18	18-24	24-36	38-48	48-6	30	60+
Stream Width (ft.)	Top of Bar	k (at crossing	location):	Ø'	Water Surface	e (at crossing	location):	ĵ۸·	HWIN	a U'
Bank Height (ft.) (looking downstream else	Left	0-2	2-	4	4-6	3	6-8			<b>(a)</b>
give direction you are facing here:J)	Right	0-2	2.	4	4-6	3	6-8	·		<b>(O)</b>
"ank Slope (9	Left	0-20	, 20-	40	40-6	50	60-80	-		80+
oking downstream else alive direction you are facing here:	Right	. 0-20	20-	40	40-6	50	60-80			<b>®</b> +)

Jate: 3-17-6	Client/Project Name	& No.: Southern			Milepost:		
QUALITATIVE A	TTRIBUTES						
Water Appearance	Clear	slightly Turbid	Turbid		Very Turbid	Color:	
	Floating algal mats	Obvious aurface scum	Sheen	on surface	Greenish color	Other:	
Stream Substrate %	Bedrock	Gravel_CO	Sand_	40	Sitt/Clay	Organic	
Aquatic Habitate	Sand Bar	Gravel Bar	Mud Ba	ır	Gravel Riffles	(Deep Pools	
Undercut Banks	trees/shrubs	In-stream emergent plants Percent Cover	plants	m submerged	Blank root systems	Fringing Wetlands	
Aquatic Organisms Observed	Waterfowl Snakes	Fish (adult) Other:	Fish (ju	venile)	Frogs	Turtles	
	Invertebrates:	Intolerant	(Facultai	tive	Tolerant	None	
· · · · · · · · · · · · · · · · · · ·	Circle vegetative layers:						
Tributary is	Natural	(Natural ) Artilicial (Man-Made) Manipulated (Explain below) (Stable) / Unstable					
Channel Condition	Channelization/Braiding	Unnatural straightening	Downe	cutting	Dikes/Berms	Excessive bank erosio	
Teturbances	Livestock access to ri  Waste discharge pipe		,	ĺ	stream or on banks	2100FF	
T/E SPECIES / SUITAB	LE HABITAT			Habita	at ID No.:		
n on	e observed			···			
Comments (e.g. pipeline	e crossing angle, construction	constraints, erosion potentia	I, existing d	 fisturbances, and	meanders)		
perennia wider t	l Stroath i	deeply meis	,		is much	`	
STREAM QUALITY (Inc	dicate)	ligh ,,,,,,	(1) Mo	derate	① Low		
any dikes/levies are set bac protected by roots that exite cover types available; diver	annel (no structures or dikes; no only to provide access to adequate the control to the base-flow elevation; we are and stable aquatic habitat; no dichannel evidenced by rip rap and channel evidenced by rip rap and stable access to the control of	flood plain; natiral Végetation es ater clear to tea-colored; no barr disturbance by livestock or man	itends at leas iers to fish n ; intolerant i	st one or two active movement (selfonal macroinvertebrates	channel widths on each s walter withdrawals preve present.	ide; banks stable and ntlim@Yement); many fish	

habitat; minimum disturbance by livestock or man; Facultative macroinventebrates present. Low Quality: Channellis actively downkutting or wideling; rip rap and channelization elicessive; flood plain restricted by dikes/levees; natural vegetation less than 1/3 of the tive channel width on each side; lack of regeneration; filtering function severely compromised; Banks liftitiable (inside and outside bends actively eroding with numerous allen trees); water very turbid to muddy; obvious pollutants (algal mats, surface scum, surface sheen); heavy odor; green color to water; severe barriers to fish movement; 2-0 fish COVERTYPES available; little to no aquatic habitat; severe disturbance by livestock or man; tolerant or no macroinvertebrates present.

channel width on each side; filtering function of diparian vegetation only moderately compromised; banks moderately unstable (outside bends actively eroding with few fallen trees); considerable water cloudiness, submerged objects covered with green film; moderate odor; minor barriers to fish movement; 4-3 fish cover types available; fair aquatic

#### **WATERBODY**

Waterbody Name:	<u> </u>					Waterbody I	ID No.:	SIA	$\alpha$	205	_
Centerline Re-R	oute A	ccess Road	l Wareho	use Site	Other:	Associated '	Wetland No	. <b>:</b>			
Date: 3-17-00	\ Client	/Project Na	me & No.:	Southe			Milepost	:			
Investigators: TAC	11M		State/County			develar	Quad Na	ame:	Con		
	<del>/ V ' `</del>	age No.:	)-/ \$ Block/L	ot/Tract No.		Picture		19	<u> </u>	wex	
PHYSICAL ATTRIB			<u></u>		•						
Waterbody Sketch P											
Please include: Directi		rth Arrow, (	Centerline, L	ength of fea	ture, Dist	ances from C	enterline, Ph	oto Lo	cations	, and	
Survey corridor				ı C					κ i	<b>&gt;</b> >	
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				(			•				
						Angle of Cros	ssing at Cer	nterlin	<b>e:</b>		
Waterbody Type	Lake	Pond	Borrow Pit	River	(Stream)	Ag. Ditch	Other:				Ŧ
Stream Flow	Fast		Moderate	··	Slow		Very Slow			(Non	9
Flow type		(Flows > 3	Intermittent/S			(Flows only in	Direction:		_		7
	months an	inually)	(Flows <3 mo annually)	ntas	response	to rainfall)	Number of Ar	nnual Fk	ow Event	.s	
OHWM Indicator NUDY	Clea	ır natural line (	on bank	Shelving	Wreste	d vegetation	Scour		Water S	taining	_
Bent, matted or missing v	egetation	Soil charac	cter changes	Abrupt p	lant commu	nity change	Wrack line	ı	Litter and	i debris	
Sinuosity	Str	raight	Slig (Mean	dering	Subsu	rface Flow?	Yes	No	,	Unknown	
Stream Depth (In.)	(6)	3-6	6-12	12-18	18-24	24-36	36-48	48-0	30	60+	
Stream Width (ft.)	Top of Bar	nk (at crossing	location):	1	Water Sur	face (at crossing	location):	)	OH	UM C	1
Bank Height (ft.) (looking downstream else	Left	0-2	2-	4)		4-6	6-8			8+	_
give direction you are	Right	0-2	₹2-	<u> </u>		4-6	6-8			8+	
facing here:) Bank Slope (*)	Left	0-20	20	<del>,/</del>		40-60	60-80	>		80+	
oking downstream else									-		
.ve direction you are facing here:)	Right	0-20	20-	40		40-60	60-80	<u>)                                    </u>		80+	

Date: 3-17-5	Client/Project Name	& No.: Souther,	Δ		Mllepost:		
QUALITATIVE AT	TRIBUTES	•					
Water Appearance	Clear	Slightly Turbid	Turbid		Very Turbid	Color:	
none	Floating algal mats	Obvious surface scum	Sheen	on surface	Greenish color	Other:	
Stream Substrate %	Bedrock	Gravel	Sand_	· · · · · · · · · · · · · · · · · · ·	Silviciay) 100	Organic	
Aquatic Habitats	Sand Bar	Gravel Bar	Mud Ba	ır	Gravel Riffles	Deep Pools	
Undercut Banks	rees/shrubs	In-stream emergent plants Percent Cover	m submerged	Bank root systems	Fringing Wetlands		
			<del></del>	t Cover			
Aquatic Organisms Observed	Waterfowl	Fish (adult)	Fish (ju	vënile)	Frogs	Turtles	
none	Snakes Invertebrates:	Other:	Faculta	6h.a	Tolerant	Mana	
		L				None	
Riperian Zone	_	zone from edge of active cha	unnel out o	into flood plain: .	100+ (n)		
,	Circle vegetative layers: t	lees) shrubs (herbs)			•		
	☐ Significant bare areas	within riparian zone		mix	ced pine	/HW	
	Evidence of non-buffe	red concentrated flows					
Tributary is	Natural	(Natural) Artificial (Man-Made) Manipulated (Explain below) (Stable) / Unstal					
Channel Condition	Channelization/Braiding	Unnatural straightening	Down	culting	Dikes/Berms	Excessive bank erosion	
)isturbances	Livestock access to ri	parlan zone		☐ Manure in	stream or on banks		
	☐ Waste discharge pipe	s present		SO Other:	none_		
T/E SPECIES / SUITABI	LE HABITAT_			Habit	at ID No.:		
none	observed						
Comments (e.g. pipelline	crossing angle, construction	constraints, erosion potential,	existing o	listurbances, and	meanders)		
Small epheneral channel beging at northern edge of por							
STREAM QUALITY (Ind	licate) DI H	ligh #==	Ø Mo	derate	, 🖾 Low		
High Quality: Natural cha any dikes/levies are set back protected by roots that eliter cover types available; diven Moderate Quality: Altered	STREAM QUALITY (Indicate)  High  High  High  Moderate  Moderate  Low  High Quality: Natural channel (no structures or dikes; no evidence of downcutting or excessive lateral cutting); evidence of past channel alteration with significant recovery; any dikes/levies are set back to provide access to adequate flood plain; natural vegetation extends at least one or two active channel widths on each side; banks stable and protected by roots that extend to the base-flow elevation; water clear to tea-colored; no barriers to fish movement (seasonal water withdrawals pre-eit movement); many fish cover types available; diverse and stable aquatic habitat; no disturbance by livestock or man; intolerant macroinvertebrates present.  Moderate Quality: Altered channel evidenced by rip rap and/or channelization; dikes/levees restrict flood plain width; natural vegetation extends 1/3-1/12 of the active channel width on each side; filtering function of riparian vegetation only moderately compromised; banks moderately thistable (outside bends actively eroding with few fallen						

trees); considerable water cloudiness, submerged objects covered with green film; moderate odor, minor barriers to fish movement; 4-3 fish cover types available; fair aquatic habitat; minimum disturbance by livestock or man; Facultative macroinvertebrates present. ow Quality: Channel is actively dowifeuting or widening; rip rap and channelization excessive; flood plain restricted by dikes/levees; natural vegetation less than 1/3 of the

Clive channel width on each side; lack of regeneration; filtering flifelion severely compromised; Banks unstable (inside and outside bends actively eroding with numerous fallen trees); water very turbid to muitaly; obvious pollutants (algal mais, suiface seum); heavy odor; green color to water; severe barriers to fish movement; 2-0 fish cover types available; little to no aquatic habitat, severe disturbance by livestock or man; tolerant or no macroinventebrates present.

#### WATERBODY

'aterbody Name: Voadside ditch Waterbody ID No.: Re-Route Warehouse Site Other: Centerline **Access Road** Associated Wetland No.: Date: Client/Project Name & No.: Milepost: State/County/Municipality: Investigators: Quad Name: Cheroner Logbook No.: Logbook Page No.: >0-> Block/Lot/Tract No.: Picture No.: 3-**5** PHYSICAL ATTRIBUTES Waterbody Sketch Plan Please include: Directional & North Arrow, Centerline, Length of feature, Distances from Centerline, Photo Locations, and Survey corridor NV, grass hillside Angle of Crossing at Centerline: Lake **Waterbody Type** Pond **Borrow Pit** River Stream AD buch Other: (Mone Stream Row Fast Moderate Slow **Very Slow** Direction:_ St Flow type Perennial (Flows;> 3 Interm Ittent/Seasonal Ephemeral (Flows only months annually) response to raintall (Flows <3 months Number of Annual Flow Events annually) **OHWM Indicator** Clear natural line on bank Sheiving Wrested vegetation Scoul Water Staining Soil character changes Litter and debris Bent, matted or missing vegetation Abrupt plant community change Wrack line Straigh Sinuosity Meandering Subsurface Flow? Yes No Unknown Stream Depth (in.) 0.3 3-6 12-18 24-36 36-48 48-60 60+ 6-12 18-24 a 6tHwM Stream Wight (ft.) Top of Bank (at crossing location): (B) Water Surface (at crossing location): Bank Height (ft.) 2-4 4-6 Leeft 0.2 6-8 (looking downstream else give direction you are 4-6 Rigilit 0-2 6-8 8+ facility here: nk@lope:(\$) 40-60 **Left** 0-20 2040 60-80 80+ alking downstream else 20-40 Right 0.20 60-80 80+ give direction you are facing here:

SIACHOOI

Jate: 3-18-00	Client/Project Name 8	& No.: Southern			Milepost:	
QUALITATIVE AT	TRIBUTES					
Water Appearance	Clear	Slightly Turbid	Turbid		Very Turbid	Color:
none	Floating algal mats	Obvious surface scum	Sheen	on surface	Greenish color	Other:
Stream Substrate %	Bedrock	Gravel CO We	Sand_C	20	Sllt/Clay	Organic
Aquatic Habitats	Sand Bar	Gravel Bar	Mud Ba	ır	Gravel Riffles	Deep Pools
Undercut Banks	Overhanging trees/shrubs					
Aquatic Organisms	ma Waterfowl Fish (adult) Fish (juvenile) Frogs Turtles					
Observed	Snakes	Other:			1	1
none	Invertebrates:	Intolerant	Facultat	live	Tolerant	None
Riparlan Zone	Width of natural vegetation	zone from edge of active chan	nel out o	nto flood plain:	(n)	
	Circle vegetative layers: ti	rees shrubs herbs				
	Significant bare areas	within riparian zone				
	Evidence of non-buffe	red concentrated flows				
Tributary is	Natural	Articial (Man-Made)	Manip	ulated (Explain bei	>w)	Stable / Unstable
Channel Condition	Channelization/Braiding	Unnatural straightening	Downo	cutting [	Dikes/Berms	Excessive bank erosion
Vaturbances	Livestock access to rip	parian zone		Manure in st	lream or on banks	
	☐ Waste discharge pipe	s present		Other:	if rap	
T/E SPECIES / SUITABL	E HABITAT			Habitat	ID No.:	
none	observed				•	
Comments (e.g. pipeline	crossing angle, construction	constraints, erosion potential,	existine d	listurbances, and m	eanders)	
<del> </del>					ants	
r oadside	difth se	stensive rig	- 40	ip bn v	ants	
				•		
OTDEAM OHATTY /L	icate) 20 H	iah	2) Mo	dorata	" <b>5</b> Low	<del></del>
STREAM QUALITY (Indi High Quality: Natural char		igh widence of downcutting or tixcess		derate cutting); evidence of		with significant recovery
any dikes/levies are set back	to provide access to adequate fl	lood plain; natural vegetation extenter clear to tea-colored; no barries	nds at lear	at one or two active c	hannel widths on each	side; banks stable and
cover types available; divels	e and stable aquatic habilit; no	disturbance by livestock or man; i	ntolerant i	macroinvertebraltes p	resent.	•
		d/or channelization; dikes/levers : getation only moderately compron				

ow Quality: Channel is actively downcutting or widening; rip rip and channelization excessive; flood plain restricted by dikas/lievees; natural vegetation less than 1/3 of the tive channel width on each side; lack of regeneration; filtering function severely compromised; Banks unstable (inside and outside beights actively eroding with numerous fallen trees); water very turbid to muddy; obvious polluthits (algal mats, surface scum, surface sheen); heavy odor; green color to water; severe barriers to fish movement; 2-0 fish cover types available; little to no aquatic habitat; severe disturbance by livestock or man; tolerant or no macroinvertebrates present.

trees); considerable water cloudiness, submerged objects covered with green film; moderate odor; minor barriers to fish movement; 4-3 fish cover types available; fair aquatic

habitat; minimum disturbance by livestock or man; Facultative macroinvertebrates present.

7041 Old Wake Forest Road, Suite 103, Raleigh, NC 27616 T: 919.872.6600 F: 919.872.7996

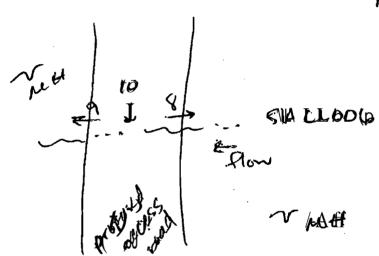
#### WATERBODY

LINOK	AECOM
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Branch Ut to Ponders Waterbody ID No.: Centerline Re-Route Access Road Warehouse Site Other: **Associated Wetland No.:** Date: 3--18 ClienVProject Name & No.: Milepost: Investigators: State/County/Municipality: Quad Name: Logbook No.: Logbook Page No.: 70-7 Block/Lot/Tract No.: Picture No.: **PHYSICAL ATTRIBUTES** 

Waterbody Sketch Plan

Please include: Directional & North Arrow, Centerline, Length of feature, Distances from Centerline, Photo Locations, and Survey corridor



Angle of Crossing at Centerline: _

Waterbody Type	Lake	Pond	Borrow Pit	River	(Stream)	Ag. Ditch	Other:		
Stream Flow	Fast		Moderate		Slow		Very Slow		None
Flow type		(Flowes > 3	Intermittent/S		Ephemeral (I		Direction:		
	months an	nually)	(Flows <3 mo	onlhs	response to	rainfall)	Number of Ar	nnual Flow E	vents
OHWM Indicator	(lea	r natumalillime	ordbank	Shelving	Wrested v	egetation	Scour	Wat	er Staining
Bent, matted or missing v	regetation	Seit Char	acter changes	Abrupt	plant community	/ change	Wrack line	Litte	and debri
Simuosity	Str	aigh	Méan	dering	Subsurface Flow?		Yes	No	Unknown
Stream Depth (In.)	0-3	· <b>3</b> -6	(6: 13)	12-18	18-24	24-36	36-48	48-60	60+
Stream Width (ft.)	Top of Bar	nk (at crossin	g location):		Water Surface (at crossing		location):	3' 6	MACUM 31
Bank Height (ft.) (looking downstream else	Left	0-2	Q _X	3)	4-	6	6-8		8+
give direction you are facing here:	Right	0-2	(2-	49	4-	6	6-8		8+
'nkSilope (°)	Left	0-20	(20	40)	40-	60	60-80		60+
oking downstream else give direction you are tacing here:)	Right	0-20	20-	40	40-	60	60-80		<b>A</b>

ENSR AECOM

rate: 3-18-04	Client/Project Name 8	Milepost:				
QUALITATIVE AT	TRIBUTES					
Water Appearance	Clear Slightly Turbid Turbid		Very Turbid	Color:		
	Floating algal mats	Obvious surface scum	Sheen	on surface	Greenish color	Other:
Stream Substrate %	Bedrock	Gravel	Sand		Sill(Cia) Col	Organic
Aquatic Habitats	Sand Bar	Gravel Bar	Mud Ba	ır	Gravel Riffles	Reep Pools
Undercut Banks	Overhanging trees/shrubs	In-stream emergent plants	in-strea plants	m submerged	Bank root systems	Fringing Wetlands
		Percent Cover	Percen	t Cover		
Aquatic Organisms Observed	Waterlowl	Fish (adult)	Fish (ju	venile)	Frogs	Turtles
Cuspited	Snakes	Other:	•			
	Invertebrates:	Intolerant	Facultative To		Tolerant	None
·	Circle vegetative layers: (to Circle					
Tributary is	(Natural )	Artificial (Man-Made)	Manip	ulated (Explain b	pelow)	Stable / Unstable
Channel Condition	Channelization/Braiding	Unnatural straightening	Down	cutting	Dikes/Berms	E cessive bank erosion
sturbances	Livestock access to ri	parlan zone		Manure in	n stream or on banks	
····	☐ Waste discharge pipe	Vaste discharge pipes present  Other: none				
T/E SPECIES / SUITABL	LE HABITAT			Habi	tat ID No.:	
none	observed					
Comments (e.g. pipeline	crossing angle, construction	constraints, erosion potentia	l, existing o	listurbances, and	d meanders)	

STREAM QUALITY (indicate)	1 High	Maderatel erated	Low

High Quality: Natural chititatel (no stitute or dikes; no evidence of downcutting or excessive lateral cutting); evidence of past channel alteration with significant recovery; any diless/levies are set back to provide access to adequate flood plain; natural vegetation extends at least one or two active channel widths on each side; banks stable and protected by roots that extend to the base-flow elevation; water clear to tea-colored; no barniers to fish movement (seasonal water withdrawals prevent movement); many fish cover types available; diverse and stable aquatic habitat; no disturbance by livestock or man; intolerant macroinvertebrates present.

Moderate Quality: Altered channel evidenced by rip rap and/or channelization; dikes/levees restrict flood plain width; natural vegetation extends 1/1931/12 of the active channel width on each side; filtering function of riparian vegetation only moderately compromised; banks moderately unstable (outside bends actively eroding with few fallen trees); contiderable water cloudiness. Is it brue ged objects covered with green film; moderate odor; minor barriers to fish movement; 4-3 fish cover types available; fair aquatic habitat; minimum disturbance by livestock or man; Facultative macroinvertebrates present.

w Quality: Channel is actively downcutting or widehing; rip rap and childhelization excessive; flood plain restricted by dikes/levees; natural vegetation less than 1/3 of the ive channel width on each side; lack of regeneration; filtering furiction severely compromised; Banks willtable (inside and outside bends actively eroding with numerous fallen trees); water very turbid to muddy; obvious pollutants (algal mats, surface seum, surface sheen); heavy odor; green color to water, severe barriers to fish movement; 2-0 fish cover types available; little to no aquatic habitat; severe disturbance by livestock or man; tolerant or no macroinvertebrates present.

#### WATERBODY

ENSR AECOM

'aterbody Name: UT to Porders Branch v

Waterbody ID No.:

SIACLOOT

Centerline

Re-Route

Access Road

Warehouse Site

Other:

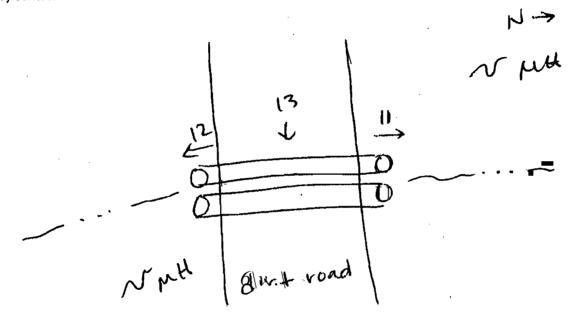
**Associated Wetland No.:** 

Date: 3-18-09	Client/Project Name & No.: Southern	Milepost:
Investigators: JAC	State/County/Municipality:	IC/Cleveland Quad Name: Grover
Logbook No.: Log	book Page No.: 36- Block/Lot/Tract No.:	Picture No.: (1 - 13

#### **PHYSICAL ATTRIBUTES**

Waterbody Sketch Plan

Please include: Directional & North Arrow, Centerline, Length of feature, Distances from Centerline, Photo Locations, and Survey corridor



Angle of Crossing at Centerline:

Waterbody Type	Lælke	Pond	Borrow/Pit	River	Stream	Ag., Ditch	Other:		
Stream Flow	Fast		Moderate		Slow		Very Slow		None
Flow type		nial (Flows > 3 intermittent/Seasonal (Flows <3 months annually)		Ephemeral (Flows only in response to rainfall)		Direction: Number of Annual Flow Events		vents	
OHWM Indicator	CO	natural line	on bank	helving	Wreste	d vegetation	Scour	Wate	r Staining
Bent, matted or missing v	egetation	Soil chara	cter changes	Abrupt p	lant commun	nity change	Wrack line	Litter	and debris
Sinuosity	Stra	aight	Mean	dering	Subsurface Flow?		Yes	No	Unknown
Stream Depth (in.)	0-3	(3-63)	6-12	12-18	18-24	24-36	36-48	48-60	60+
Stream Width (ft.)	Top of Ban	k (at crossin	g location):		Water Surface (at crossing		location):	f)H	WIM.
Bank Height (ft.) (lookling downstream else	Left	<b>a</b>	2-4		4-6		6-8		8+
give direction you are facing here:)	Right	<b>@</b>	2-	4		4-6	6-8		8+
'nk S/ope(°)	Left	0-20	20-40		40-60		60-80		80+
oking downstream else give direction you are facing frame re:	Right	0-20	20-	40	C	10-60	60-80		80+

ENSR AECOM

Jate: 13 - 18 - C	Client/Project Name	& No.: Souther	<u> </u>	·	Milepost:	
QUALITATIVE A	TTRIBUTES					
Water Appearance	Clear	Slightly Turbid	Turbid		Very Turbid	Color: Su Jean
	Floating algal mats	Obvious surface scum	Sheen	on surface	Greenish color	Other:
Stream Subatrate %	Bedrock	Gravel_U(6	Sand	<u>.</u>	SilvClay	Organic (C)
Aquatic Habitats	Sand Bar	Gravel Bar	Mud Ba	r	Gravel Riffles	Deep Pools
Undercut Banks	Overhanging trees/shrubs	In-stream emergent plants Percent Cover	In-stream submerged plants Percent Cover		Bank root systems	Fringing Wetlands
Aquatic Organisms	Waterfowl	Fish (adult)	Fish (j)w		Frogs	Turtles
Observed	Snakes	Other:	1	<b>,</b>		
	Invertebrates:	Intolerant	Facultat	íve .	Tolerant	None
	Circle vegetative layers:  Significant bare area:  Evidence of non-builti					
Tributary is	(Vatural)	Artificial (Man-Made)				Stable / Unstable
Channel Condition	Channelization/Braiding	Unnatural straightening	Downcutting Dikes/Be		Dikes/Berms	Excessive bank erosion
laturban@a	U Ulvestock access to r	lparian zone		Manure i	n stream or on banks	
	Waste discharge pipe	es present		Other:		
T/E SPECIES / SUITAE	BLE HABITAT			Hab	Itat ID No.:	
none	observed					
Comments (e.g. pipelir	ne crossing angle, construction	constraints, erosion potentia	l, existing d	isturbances, an	d meanders)	
old Pan			trea		-A	
2 CHNCKE	the CM-1 ven	its milte	oot i	ves ide	diamek	<i>x</i> -
STREAM QUALITY (In	dicate) 2		Z INO	fireto de	rated Low	

protected by roots that extend to the base-flow elevation; witter clear to tea-colored; no barriers to fish movement (seasonal water withdrawals prevent movement); many fish cover types available; diverse and stable aquatic habitat; no disthifbance by livestock or man; intolerant macroinvertebrates present.

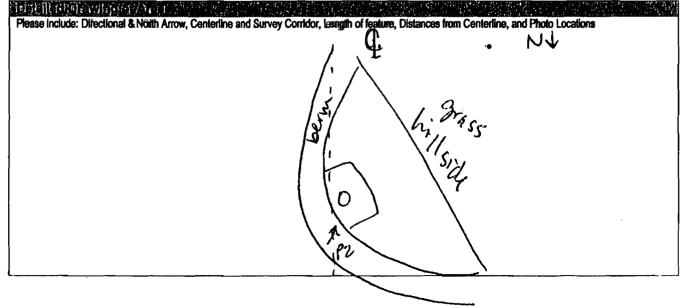
Moderate Quality: Altered channel evidenced by rip rap and/or channelization; dikes/levees restrict flood plain width; natural vegetation extends 1/3-1/2 of the active channel width on each side; filtering function of riparian vegetation only moderately compromised; banks moderately unstable (outside bends activety eroding with few fallen trees); considerable water cloudiness, submerged objects covered with green film; moderate odor; minor barriers to fish movement; 4-3 fish cover types available; fair aquatic habitat; minimum disturbance by livestock or man; Facultative macroinvertebrates present.

ow Quality: Channel is actively downcutting or widening; rip rap and channelization excessive; flood plain restricted by dikes/levees; natural vegetation less than 1/3 of the tive channel width on each side; lack of regeneration; fillering function severely compromised; Banks with table (inside and outside bends actively eroding with numerous fallen trees); water very turbid to muddy; obvious pollutants (algal mats, suifface seum, sunface sheen); heavy odor; green color to water; severe barriers to fish movement; 2-0 fish cover types available; little to no aquatic babitat; severe dislumbance by livestock or man; tolerant or no macroinvertebrates present.

#### **MAN-MADE FEATURE**

Feature ID#: MANIA CHOO!

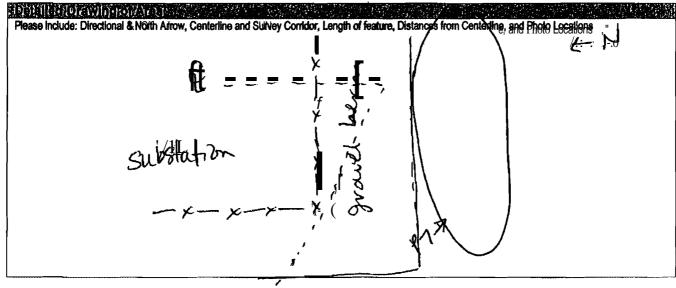
	cillary Facility DOt			
Date: 3-18-09 Client/Project Name: South	ern	Milep	ost Enter/Exit:	
Investigators: JAC/JM State	County: SC/Ches	okee	Quad Name:	Grover
Logbook No.: Logbook Pg. No.: (A) Tract No.:		Picture No.:	2	
Feature Type:	· <u> </u>			
D Groundwater Well for Residence				
D Groundwater Well for Flood Irrigation				
6 Groundwater Well for Center Pivot Irrigation				•
6 Residential Structure				
D Fence Post				
O Utility Pole for Transmission Line				
D OIVGas Well				
D Office Building	•			
□ School				
O Bam				
D Sìlo	•			
D Storage Shed				
O Park				
D Recreation Area				
O Waste Disposal Site				
© Campground				
O Golf Course				
D Orchard	•			
D Nursery				
6 Quarry				
at other Stand widthear, lasin				
Approximate distance and direction from centerline?	Centerin	c cros	ses b	erm
		N		



#### **MAN-MADE FEATURE**

Feature ID#: MANCHOO2

Oenterline   Client/Project Name:   Ancillary Facility   Date: 2 1d   DO   Client/Project Name:   Client/Project N	Other: Milepost Enter/Exit:
Date: 3-18-09 Client/Project Name: Sbuthlin	
Investigators: JAC/JM State/County: SC/C	Cherokee Quad Name: Grover
Logbook No.: Logbook Pg. No.: 24 Tract No.:	Picture No.: 7
Feature Type:	
D Groundwater Well for Residence	
D Groundwater Well for Flood Irrigation	
D Groundwater Well for Center Pivot Irrigation	
□ Residential Structure	
D Fence Post	
D Utility Pole for Transmission Line	
D Oil/Gas Well	•
D Office Building	
D School	
DBam	
D Silo ·	
D Storage Shed	
D Park	
D Recreation Area	
D Waste Disposal Site	
D Campground	
□ Golf Course	
D Orchard	
O Nursery	
D Quarry	
pother Stormwater basin	
Approximate distance and direction from centerline?	



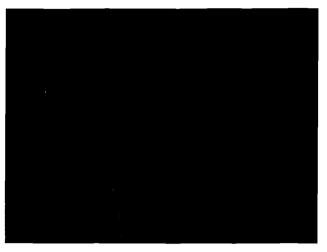
Appendix B

**Photographs** 

#### Wetlands



W1ACH001_031809_001_W



W1ACH002_031809_006_SW



S1ACL001_031709_002_N



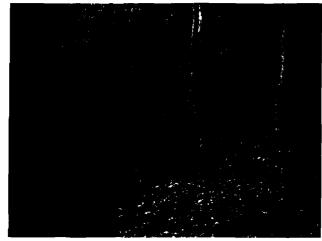
S1ACL001_031709_004_W



S1ACL001_031709_003_S



S1ACL001_031709_005_N



S1ACL001_031709_006_S



S1ACL002_031709_008_N



S1ACL001_031709_007_E



S1ACL002_031709_009_S



S1ACL002_031709_010_W



S1ACL003_031709_012_E



S1ACL003_031709_011_W



S1ACL003_031709_013_N



S1ACL004_031709_014_N



S1ACL004_031709_016_W



S1ACL004_031709_015_S



S1ACL005_031709_017_N



S1ACL005_031709_018_S



S1ACH001_031809_003_NW



S1ACL005_031709_019_W



S1ACH001_031809_004_SE



S1ACH001_031809_005_SE



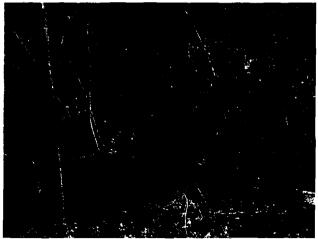
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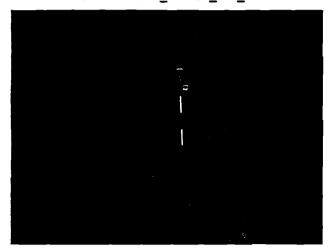
SAR1ACL006_031809_008_N



SAR1ACL006_031809_010_E



SAR1ACL007_031809_011_N



SAR1ACL007_031809_013_E



SAR1ACL007_031809_012_S

#### Man-Made Features



MAN1ACH001_031809_002_S



MAN1ACH002_031809_007_SE

## Appendix C

Technical Report: Ground Penetrating Radar (GPR) Survey of the Old Shiloh Presbyterian Church Cemetery

# Ground Penetrating Radar (GPR) Survey of the Old Shiloh Presbyterian Church Cemetery

Cleveland County, North Carolina and Cherokee County, South Carolina





# Ground Penetrating Radar (GPR) Survey of the Old Shiloh Presbyterian Church Cemetery

Cleveland County, North Carolina and Cherokee County, South Carolina

Report submitted to:
Mr. Kevin Gammill, Southern Power Company • 600 North 18 th Street/15N-8198 • Birmingham, AL 35291
Report prepared by:  New South Associates • 6150 East Ponce de Leon Avenue • Stone Mountain, Georgia 30083

Tham M. Path

Shown Patch - Primcipal Investigator and Author

September 29, 2008 • Final Report New South Associates Technical Report 1662

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#### **ABSTRACT**

On September 2, 2008, New South Associates conducted a ground penetrating radar (GPR) survey of a limited portion of the Old Shiloh Church Cemetery in Cleveland County, North Carolina and Cherokee County, South Carolina. The survey had two major goals: first, to investigate the possibility of unmarked graves along the southern boundary of the cemetery; and second, to investigate an isolated grave west of the main cemetery.

The GPR survey covered the equivalent of approximately 361 square meters in the two areas. However, the actual area is larger because multiple transects were extended beyond the established grids. This area is difficult to calculate in absolute terms because of the irregularity. Basically, this method allows an operator to navigate around, and up to, large obstacles that might otherwise prove impossable. Survey along the southern boundary was accomplished in both the X (east) and Y (north) directions to provide better accuracy and increased sampling density. Only the Y (north) direction was necessary over the Dover grave, west of the main cemetery.

Results indicate the presence of two possible unmarked graves in the southern survey area that is also within the formal cemetery boundary. There is no evidence of any unmarked graves south of the current boundary (topography adjacent to the road). GPR data for the Dover grave is inconclusive, with no obvious anomalies that might be interpreted as graves. However, the death date of 1788 makes this one of the oldest graves in the cemetery. Age of a burial is one of the critical factors affecting its overall chances of being successfully detected with GPR. Although the GPR data does not necessarily indicate a grave, it would be irresponsible to ignore the existing marker. A revised cemetery boundary was GPS-plotted to facilitate the preservation of the cemetery.

# **ACKNOWLEDGEMENTS**

This project would not have been possible with the generous support and assistance from Kevin Gammill, siting engineer for Southern Power Company. Kevin was instrumental in providing background information and was available for a site visit to assess the potential for GPR. Lauren Souther provided assistance with the fieldwork.

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## I. INTRODUCTION

New South Associates conducted a ground penetrating radar (GPR) survey of a limited portion of the Old Shiloh Church Cemetery in Cleveland County, North Carolina and Cherokee County, South Carolina (Figures 1-2). Fieldwork was conducted by Shawn Patch, with assistance from Lauren Souther. The survey had two major goals; first, to investigate the possibility of unmarked graves along the southern boundary of the cemetery; and second, to investigate an isolated grave west of the main cemetery.

The GPR survey covered the equivalent of approximately 361 square meters in the two areas. However, the actual area is larger because multiple transects were extended beyond the established grids. This area is difficult to calculate in absolute terms because of the irregularity. Basically, this method allows an operator to navigate around, and up to, large obstacles that might otherwise prove impassable. Survey along the southern boundary was accomplished in both the X (east) and Y (north) directions to provide better accuracy and increased sampling density. Only the Y (north) direction was necessary over the Dover grave, west of the main cemetery.

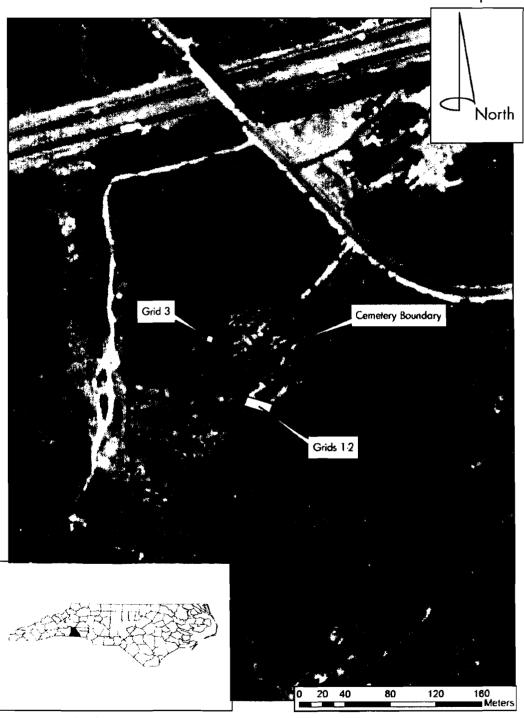
The Old Shiloh Church Cemetery is a prominent cemetery in the Cleveland County area, with several important figures buried there (Figure 3). Although a church was known to exist in the immediate vicinity at some point in the past, its original location is unknown, and there is no evidence of its presence today. There is another, more modern, church across the road; however, but it is affiliated with a different denomination and has its own cemetery.

The cemetery itself is located in a wooded area approximately 80 meters south of Elm Road (NC 2278), east of Grover, North Carolina. There are several mature trees scattered throughout the cemetery, although the grounds are well maintained with virtually no underbrush. The core area is bounded by a circular road that appears to have been there for a long time. Figures 4 and 5 show general surface conditions of the survey area as viewed from the extreme southern portion of the cemetery, with good views of the boundary road, grave layout, and vegetation. No exact count of graves is known, although it is estimated to be approximately 100, with an isolated grave located several tens of meters west of the main section, in a wooded area. Most of the graves in the main section are well marked and appear to be arranged in family plots. However, the overall candition of many individual markers is poor at best, and it is possible that several markers may have been displaced over time.

North Cemetery Boundary Grids 1-2 800 Meters 100 200 400 600 Source: USGS 7'5 Gluodroungle Grover, North Carolina

Figure 1. Location of Cemetery in Cleveland County, North Carolina and Cherokee County, South Carolina

Figure 2. Detail of Project Area



Source: 1999 Color-Infrared Aerial

Figure 3. Historic Marker



Figure 4. Photographs Showing General Surface Conditions in the Survey Area

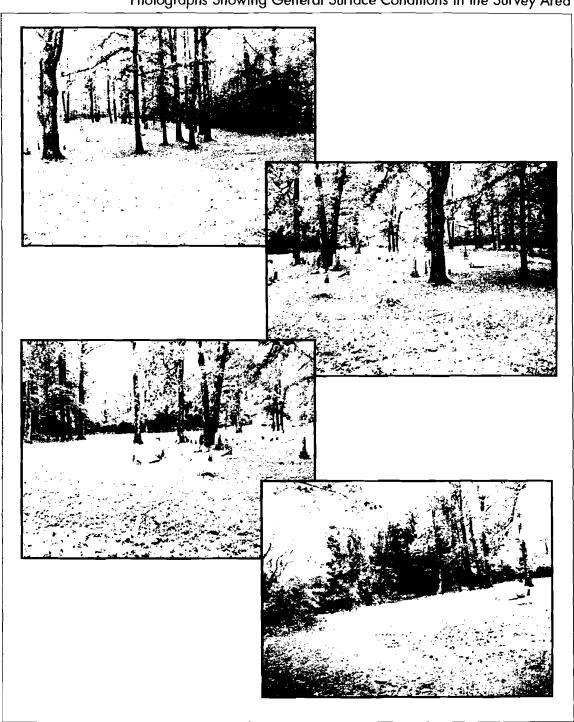


Figure 5.
Dover Grave Marker in Woods on Western Boundary of Cemetery



## II. METHODS

GPR is a remote sensing technique frequently used by archaeologists to investigate a wide range of research questions. The basic configuration consists of an antenna (with both a transmitter and receiver), a harness, and a wheel for calibrating distance. The operator then pulls the antenna across the ground surface systematically (a grid) collecting data along a transect. This data is then stored by the receiver and available for later processing and monipulation.

The premise for using GPR in archaeological applications is simple: it is generally used to find if there are buried features that might be of interest on a particular site. Because GPR is a remote sensing technique, it is non-invasive, non-destructive, relatively quick and efficient, and highly accurate when used in appropriate situations. One advantage of GPR is its obility to guide more focused, traditional excavations by targeting and/or eliminating certain areas.

The actual machine involves transmission of high frequency radar pulses from a surface antenna into the around (Conyers 2004:1). Measurements are collected from elapsed time between the pulse transmission and its reflection from buried materials and/or changes in sediments and soils. Collecting reflection profiles in a grid allows a user to construct a three dimensional map of sub-surface features. Although the technique has been around for several decades, it is only within the last few years, with new developments in unit portability and software, that archaeologists have embraced it on a wider scale.

The survey was conducted with a Geophysical Survey Systems, Inc. (GSSI) SIR 3000 control unit with an attached 400mhz antenna. The first step was to calibrate the antenna to local conditions by walking over various areas of the project area and adjusting the instrument's gain settings (Conyers 2004). Effective depth penetration was approximately 1.5 meters, which is fairly typical for clay soils in the Piedmont. There was some signal attenuation (degradation) because of the clay soils and eroded conditions over the road.

Because of the way radar energy is propagated in the ground, it is generally standard practice to collect data perpendicular to the long axis of targets (if known). Transect spacing was 50 centimeters, an interval that is well suited for identifying moderate to large sized features. For the cemetery, burials were assumed to be oriented east-west, so the initial survey was in the Y direction. To increase the overall resolution and effectiveness of the survey, data is collected over the same area in the X direction. In each case, the antenna was pulled from the baseline for each transect. Although this procedure obviously increases the field time, it generally provides more accurate results and ensures that any unknown targets have a greater chance of identification.

In order to effectively collect and process GPR data, it is necessary to establish a formal grid. In this case, grid layout was accomplished with two metric tapes and surveyor's chaining pins. The actual size, orientation, and layout of the grid was determined by surface features and presumed orientation of the targets.

Grids 1 and 2 covered the same area in two different directions. It was approximately 8x22 meters (176 square meters). However, because of surface vegetation, the actual survey area was slightly larger. Several individual transects extended beyond the grid limits and continued until they were impeded by some Grid orientation was 22 degrees, which was approximately obstacle (i.e., fenceline, tree, etc). perpendicular to the long axis of known graves.

Grid 3 was placed over the Dover grave and was 3x3 meters in size (9 square meters). It was oriented at 10 degrees, perpendicular to the marker. The purpose of this grid was to investigate the possibility that the marker had been moved from another spot and that a grave might not be present.

All data were downloaded from the control unit to a laptop computer for post-processing. GSSI has developed a proprietary program, RADAN, for analyzing and processing data. The first step was to set time zero, which tells the software where in the profile the true ground surface was. This is critical to getting accurate target depth. The second step was to apply high and low pass filters, which essentially remove background noise above and below the frequencies of 800mhz and 200mhz, respectively. Essentially, this removes horizontal banding that can result from a variety of sources and obscure smaller targets. The third and final step was to "migrate" the data, which allows the user to eliminate some of the distortion inherent in all reflection profiles and generate a more realistic view of the size, depth, and orientation of specific targets.

With the data processing complete, it was then possible to examine the grid in a three dimensional viewer within RADAN. By doing this, it is possible to rotate the grid, which appears as a block, in any direction; it can be viewed from above, in perspective, or from the X and Y axes. This is an exploratory technique and provides an overview of specific targets and possible patterning.

The next step involved "slicing" the data horizontally at specific depths. For example, a depth value can be entered (e.g. 20 cm) and then exported as a CSV file. The result is a depth "slice" of the entire grid at that point. In this case, the thickness of the slice was approximately 16 centimeters, a default value selected by RADAN. The data from this grid were sliced at regular 10-centimeter intervals to produce a systematic map of the sub-surface. Not all of these were used in the final graphics because many were redundant or did not show specific targets.

Each sliced file was then imported into SURFER for additional manipulation. This program allows users to grid data with X, Y, and Z values. The results can then be displayed in a wide range of mapping formats including contours, wireframes, and surface plots. All data were gridded using the Kriging formula and then image maps were generated from the resulting files. It was then possible to change the color values and enhance the amplitudes for better interpretation.

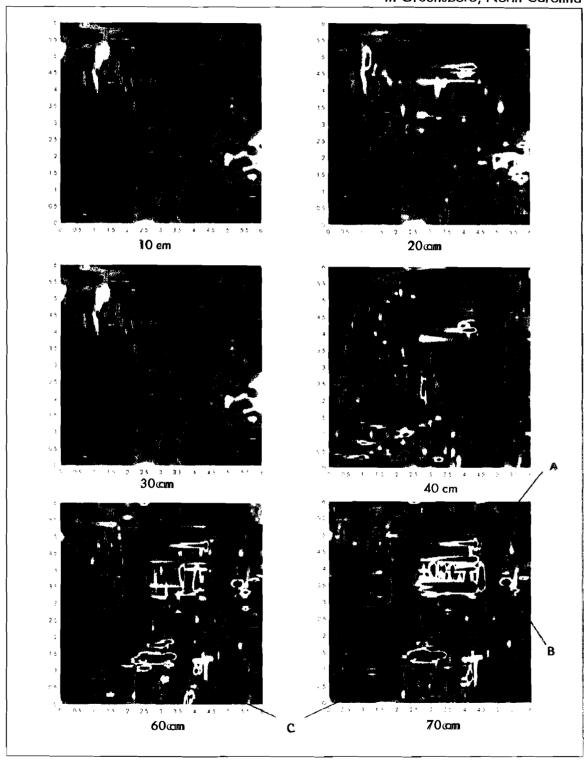
New South Associates also mapped the boundaries of the cemetery with a Trimble Pro XRS global positioning system (GPS), with sub-meter accuracy. Numerous points were collected around the perimeter, including the Dover grave, as well as the corners of each GPR grid. This data was then loaded into ArcMap and displayed on the Grover, North Carolina, USGS topographic map. The resulting map shows that a small portion of the cemetery is actually in South Carolina. However, there is a certain amount of error with scanned topographic maps, and the results should be considered with that in mind. Calculations based on the GPS data estimate the total cemetery area encompassing approximately 1.45 acres (5850 square meters). The most accurate method for determining size and boundaries would be to have the cemetery mapped by a registered land surveyor.

Most Judeo-Christian cemeteries share common characteristics with respect to burial of the dead. In general, bodies are oriented east-west, with the head facing east to face the rising sun on Judgment Day. Depths vary, but are typically between four and six feet, depending on local conditions and customs. Shapes tend to oblong and rectangular because of coffins and caskets. Sizes can vary considerably, particularly between adults and infonts, with most in the range of approximately six feet long and two feet wide.

Several factors influence the overall effectiveness of GPR for detecting graves. Soil conditions are the most important, with clay being the most difficult to penetrate. Its high conductivity causes the radar signal to attenuate much quicker, which in turns limits its overall depth and strength. Age of the groves is also critical, with alder graves being more difficult because they have had more time to decompose and are less likely to have intact coffins or caskets (if they were present to begin with). When possible, it is helpful to calibrate the GPR to local conditions by passing it over a known grave and noting the overall strength or weakness of the associated signal.

Figure 6 shows examples of both marked and unmarked graves from a GPR survey at the Old Presbyterian Cemetery in Greensboro, North Carolina, conducted in 2007. Target A is a known grave with a strong reflection. Target C is an unmarked grave with no surface indication of its presence. Its size, shape, and orientation closely parallel the signature for the known grove. These are the types of patterns that should be expected for graves identified with GPR.

Figure 6.
GPR Burial Signatures from the Old Presbyterian Cemetery
in Greensboro, North Carolina



## III. RESULTS

The following figures show color enhanced images of the processed data at different depths (i.e., 80 centimeters). There is no standard depth, and only those depths with targets are discussed in detail. The color scheme is fairly simple; values in red/white are high amplitude targets (i.e. strong reflection) while those in blue are low amplitude (no reflection). Archaeological features and/or modern intrusions should be high amplitude targets because of their compositional differences from the surrounding soil.

Figure 7 is a composite amplitude slice map of the southern survey area in the X (east-west) direction. Three different depths are shown (17, 55, and 70 centimeters, respectively). Transects in this grid began in the northeast corner and proceeded to the west until surface obstacles were encountered. The choppy appearance of the western edge of the grid is due to different transect lengths in response to heavily wooded areas. The perimeter road is clearly visible in all three slices, but is most noticeable at shallower depths. This is due to the different soil conditions and electrical properties between the road and main section of the cemetery. There are a few smaller areas with minor reflections, but no indications of unmarked graves.

Figure 8 is a composite amplitude slice map of the southern survey area in the Y (north-south) direction. Again, three different depths are shown (23, 54, and 70 centimeters, respectively). This data is of the same survey area but in the opposite direction. Transects began in the northeast corner and proceeded to the south until the terrain became impassable from heavy woods.

As with the previous maps, the perimeter road is clearly visible. However, several other targets are visible. First, the cut line/slope that separates the main section of the cemetery from the perimeter road can be seen running approximately northeast-southwest through the grid at 54 centimeters. Second, there are two small, isolated, high amplitude targets in the northwest portion of the grid between 54 and 70 centimeters that have the appearance of possible unmarked graves. In general terms, they are consistent in size, shape, arientation, and depth with the expected GPR signals for graves. There are no markers in this area or other surface indications of graves. Figure 9 is a profile of two transects showing both targets as they appear in the raw GPR data. It is somewhat surprising to see them reflected with hyperbolas of these magnitudes, and that may be an indication that they are some of the younger, more recent graves. More importantly, the GPR data does not show any high amplitude targets outside the main section of the cemetery.

Figure 10 is a composite amplitude slice map of the small grid over the Dover grave. The existing marker is shown as a small rectangle at the western edge of the grid. The GPR data for this grid is inconclusive, with no obvious hyperbolas or patterns that might indicate a grave. However, the death date on the marker clearly indicates this is one of the oldest graves in the cemetery. Given that, it is entirely possible that the body may be of insufficient contrast with the surrounding soil to be detected with the GPR. Basically, there is very little left for us to detect. Also, this grid covered a single grave, which can sometimes be problematic to identify with a high degree of confidence. Generally, it is easier to interpret the presence of unmarked graves over a larger area by looking for both individual targets and broader patterns. Even though the GPR data does not necessarily indicate a grave, it is probably best to assume that one is present for management purposes. Although the possibility of a moved stone cannot be ruled out, there is no way to know that for certain with corroborating evidence (i.e. historical record, informant interview, or disinterment).

Figure 7. Composite Amplitude Slice Map of Southern Area in the X Direction

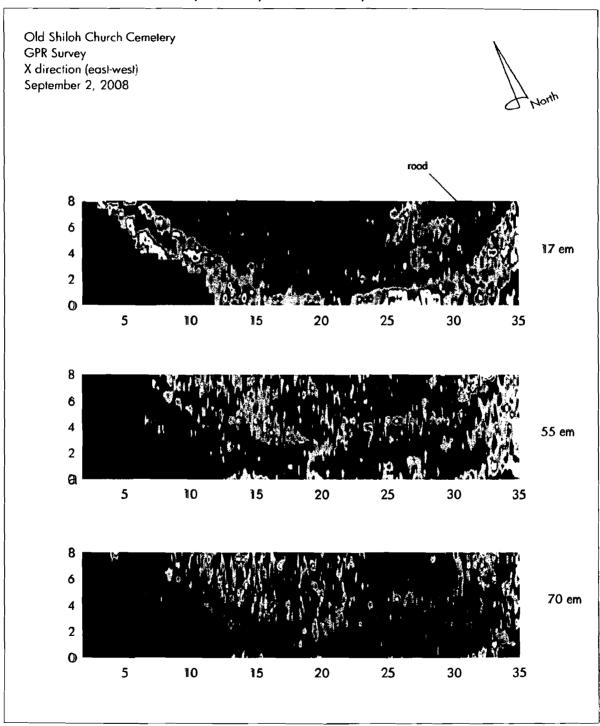


Figure 8. Composite Amplitude Slice Map of Southern Area in the Y Direction

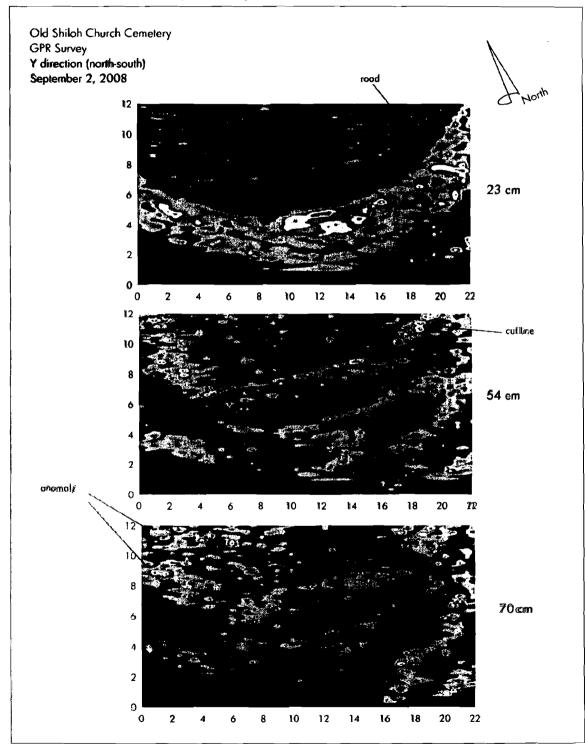


Figure 9. Two Transect Profiles Showing Individual Targets in the Raw Data

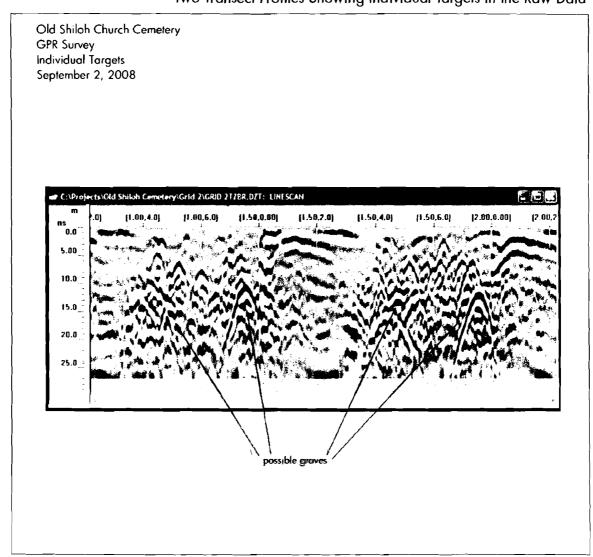
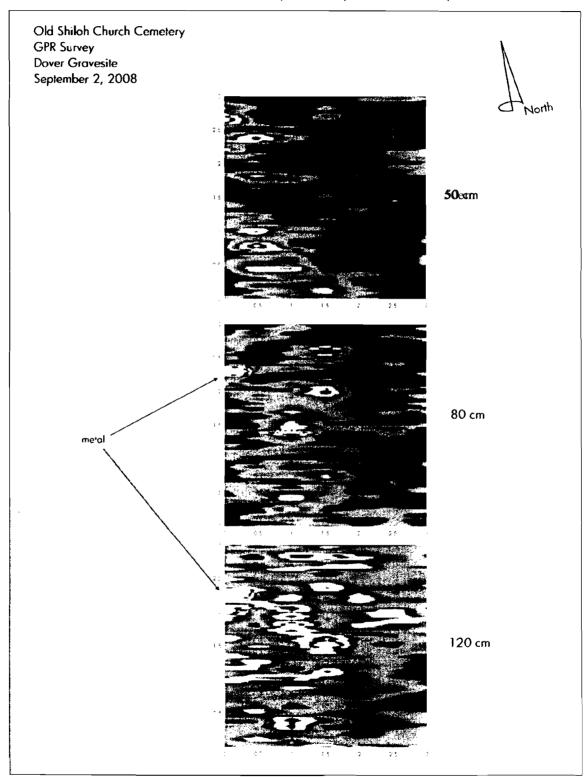


Figure 10. Composite Amplitude Slice Map of the Dover Grave



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### IV. SUMMARY AND RECOMMENDATIONS

The GPR survey identified two anomalies that could possibly be unmarked graves. While it is impossible to say with complete certainty that these are, in fact, graves, their overall characteristics (size, shape, orientation, depth, strength of reflection) make them good candidates. Both targets are in the northwest portion of the southern survey grid, inside the cemetery boundaries as circumscribed by the road. Neither of these is in any danger of being impacted.

Given the GPR results, surface conditions, and general cemetery characteristics, it is highly unlikely that additional unmarked graves are present outside the currently defined limits (i.e., south of the perimeter drive). Depth penetration with the radar was sufficient to locate expected graves up to depths of approximately 1.6 meters with a high degree of confidence. Current vegetation and grave layout are strong indicators of a formal, established cemetery with well defined boundaries. There is abundant open space throughout the cemetery so there would have been little pressure to bury bodies along the fringes. The presence of well defined family plots and sections suggests that cultural factors were strong determinants in burial placement. Surface inspection in the wooded areas all around the cemetery did not provide any firm evidence for additional graves. In fact, most of the terrain is characterized by remnant terraces, which are frequently associated with cleared agricultural fields.

The isolated Dover grave, west of the main section, does not necessarily mean additional unmarked graves are present. This particular grave is one of the earliest (1788) in the cemetery, and the marker shape, font, and inscriptions are significantly different from most of the other markers. According to a transcription of grave markers available online (http://files.usgwarchives.org/nc/cleveland/cemeteries/hambrite.txt), the earliest death dates are 1780 and 1795, with no mention of the Dover grave. Although its location is puzzling, it is not necessarily unexpected to see an isolated grave on the edge of a cemetery. The early death date could be an indication that the body was interred prior to establishment of the cemetery proper.

New South Associates recommends that a minimal buffer be established along the southern edge of the cemetery. While there is no standard distance, a range of 25-50 feet from the outer edge of the perimeter road should be considered appropriate. This distance will ensure preservation of the cemetery and its associated features.

The present study was conducted as an exercise in due diligence to investigate the possibility of unmarked graves. Given the GPR results and current conditions, it is highly unlikely that any unmarked graves exist beyond the boundaries of the cemetery, particularly on the south side. Should compliance with Section 106 of the National Historic Preservation Act (NHPA) be required in the future, it would be necessary to formally evaluate the cemetery for inclusion in the National Register of Historic Places (NRHP) and assess the effects of any proposed undertaking.

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# **REFERENCES CITED**

Conyers, Lawrence B.

2004 Ground Penetrating Radar for Archaeology. Altamira Press, Walnut Creek, California.

#### PROOF OF SERVICE

This is to certify that I, Faye A. Flowers, have served the parties as indicated below with one (1) copy of Southern Power Company d/b/a Southern Power Company-South Carolina's Application to the South Carolina Public Service Commission for a Certificate of Environmental Compatibility and Public Convenience and Necessity and a Notice of Filing pursuant to <u>S.C. Code Ann.</u> §58-33-120(2) (1976 and Cum. Supp. 2008) as follows:

#### Via U.S. Mail

C. Earl Hunter, CommissionerS.C. Department of Health and Environmental Control2600 Bull StreetColumbia, SC 29201

#### Via U.S. Mail

John Frampton, Executive Director S.C. Department of Natural Resources Post Office Box 167 Columbia, SC 29202

#### Via U.S. Mail

Ben L. Clary Cherokee County Administrator 210 N. Limestone Street Gaffney, SC 29340

#### Via U.S. Mail

Trudy Martin Blacksburg Town Administrator 105 S. Shelby Street Blacksburg, SC 29702

### Via U.S. Mail

Rick Peterson Safety/Emergency Management Director 1434 N. Limestone St. Gaffney, SC 29340-4734

#### Via Hand Delivery

C. Dukes Scott, Executive Director S.C. Office of Regulatory Staff 1401 Main Street, Suite 900 Columbia, SC 29201

### Via U.S. Mail

Chad Prosser, DirectorS.C. Department of Parks, Recreation and Tourism1205 Pendleton Street, Suite 248Columbia, SC 29201

#### Via U.S. Mail

The Honorable David Hogue Mayor of Blacksburg 105 S. Shelby Street Blacksburg, SC 29702

#### Via U.S. Mail

The Honorable L. Hoke Parris Chairman, Cherokee County Council 100 Parris Trail Gaffney, SC 29340-6736

Faye A. Flowers

Parker Poe Adams & Bernstein LLP 1201 Main Street, Suite 1450 (29201)

PO Box 1409

Columbia, SC 29202

SWORN to before me this 15th day of April, 2009

Colleen C. Quillen, Notary Public for South Carolina

My Commission Expires: May 6, 2012

### **PUBLIC NOTICE**

Southern Power Company-South Carolina ("Southern Power") is making Application to the South Carolina Public Service Commission on or about April 16, 2009, for a Certificate of Environmental Compatibility and Public Convenience and Necessity for the construction and operation of a new 230-kV interconnection transmission line in northeastern Cherokee County, South Carolina. The transmission line will originate at the natural gas-fired combustion turbine generating facility that Southern Power has proposed to build in Cleveland County, North Carolina and will connect to Duke Energy Carolinas, LLC's Ripp substation near Duke Energy's Mill Creek generating facility in Cherokee County. The portion of the transmission line in South Carolina will be approximately 1 mile in length. This Application is in accordance with S.C. Code Ann. § 58-33-10, et seq. (1976 and Cum. Supp. 2008), entitled the "Utility Facility Siting and Environmental Protection Act."

Copies of the Application, including the environmental report, will be available for public review at the following locations:

South Carolina Public Service Commission Saluda Building 101 Executive Center Drive, Suite 110 Columbia, South Carolina 29210

Cherokee County Public Library Gaffney Branch 300 East Rutledge Avenue Gaffney, South Carolina 29340

Spartanburg Public Library Headquarters Library 151 South Church Street Spartanburg, South Carolina 29306

Any person wishing to comment on the application or obtain additional information with regard thereto should contact in writing the South Carolina Public Service Commission, Saluda Building, 101 Executive Center Drive, Suite 100, Columbia, South Carolina 29210, with a copy to Faye A. Flowers, Parker Poe Adams & Bernstein LLP, 1201 Main Street, Suite 1450, Columbia, South Carolina 29201.

### LIST OF NEWSPAPERS IN WHICH PUBLIC NOTICE WAS PUBLISHED DURING THE WEEK OF APRIL 6th, 2009

The Blacksburg Times, Blacksburg, South Carolina
The Gaffney Ledger, Gaffney, South Carolina
Spartanburg Herald, Spartanburg, South Carolina

# The Gaffney Ledger

(864) 489-1131 (864) 487-7667

1604 W. Floyd Baker Blvd. – P.O. Box 670 – Gaffney, SC 29342

STATE OF SOUTH CAROLINA

COUNTY OF CHEROKEE

Personally came before me, a Notary Public for State and County aforesaid, Carolyn C. Moss, Secretary/Receptionist for The Gaffney Ledger, Inc., a newspaper published at Gaffney, South Carolina, and on oath says that the above advertisement did appear in said newspaper, and that the clipping herewith attached and made a part of this affidavit is a true copy of said advertisement as it appeared in said newspaper on _______.

Carolyn C. Moss, Secretary/Receptionist

Sworn to before me this

Notary Public for South Carolina

### PUBLIC NOTICE

Southern Power Company-South Carolina ("Southern Power") is making Application to the South Carolina Public Service Commission on or about April 16, 2009, for a Certificate of Environmental Compatibility and Public Convenience and Necessity for the construction and operation of a new 230-kV transmission line in northeastern Cherokee County, South Carolina. The transmission line will originate at the natural gas-fired combustion turbing generating facility that Southern Power has proposed to build in Cleveland County, North Carolina and will connect to Duke Energy Carolinas, LLC's Ripp substation near Duke Energy's Mill Creek generating facility in Cherokee County. The portion of the transmission line in South Carolina will be approximately it mile in length. This Application is in accordance with S.C. Code Ann. § 58-33-10, et seq. (1976 and Cum. Supp. 2008), entitled the "Utility Facility Siting and Environmental Protection Act."

Copies of the Application, including the environmental report, will be available for public review at the following locations:

South Carolina Public Service Commission Saluda Building 101 Executive Center Drive, Suite 110 Columbia, South Carolina, 29240

Cherokee County Public Biblary Gaffney Bianch 300 East Rutledge Avenue Gaffney, South Catolina, 29340

Spartanburg Public Library Headquariers Library 191 South Church Street Spartanburg South Carolina 29306-

Any person withing to comment on the application of obtain additional information with regard thereto should contact in axiiting the South Carolina Public Service Commission Saluda Building. 10.1 Executive Genter Drive Suite 100. Columbia, South Carolina 20210 with a copy to Daye A. Flowers, Parker Poe Adams & Bernstein LLP, 1201 Main Succession 1450. Columbia, South Carolina 20201.

# SPARTANBURG Herald-Journal

P.O. BOX 1657, Spartanburg, S.C. 29304 (864) 582-4511

# STATE OF SOUTH CAROLINA COUNTY OF SPARTANBURG

Alice Annas

Notary Public for South Carolina

My Commission Expires May 23, 2016

Southern Power Company, South Carolina ("Southern Power" his making Application to the South Carolina ("Southern Power" his making Application to the South Carolina Public Services Commission on or about April 12, 2009) for a Certifical Soft Environmental Compatibility and Public Convenience and Necessity 100 the construction and operation of a new 230-kV transmission line in northeastern Chep Ace Couldny, Spath Carolina. The transmission line will officinate at the natural gas and combustion the property of the Lindham faction of the Power has proposed to build in Cleveland County. North Carolina in High spath of the Duke Brergy Carolinas, LTC's Ripp substation near tank thereof. Swill creek generating facility in Cherokee County. The portion of the transmission line in South Carolina will be approximately 1 mile in length. This Application is in accordance with 5 C. Code Ach; \$ 58-33-10, et sed, (1976 and Cum. Supp. 2009), entitled the "Utility Fasility Sting and Environmental Protection Act."

Copies of the Application including the extransmental about, without stilling the control of the public reviews the following acts upon.

the application or obtain Any person wishing to comment on the application or obtain additional information with regard thereto should contact in writing the South Carolina tollic Service Commission, Saluda Building, 101 Executive Cediter Drive, Suite 100, Columbia, South Carolina 29210, with a copy to Faye A. Flowers, Parker Poe Adams & Bernstein LLP, 1201 Main Street, Suite 1450, Columbia, South Carolina 29201.

### STATE OF SOUTH CAROLINA

Personally appeared before me STEVE BLACKWELL, Publisher, or DON WILDER, CEO, who after being duly sworn, according to law, deposes and says that he is with HOMETOWN NEWS, INC., a group of newspa pers published at Spartanburg, State and County aforesaid, and that the attached advertisement was published in THE BOILING SPRINGS SENTRY, THE CHESNEE TRIBUNE, THE SPARTANBURG COUNTY NEWS, THE INMAN TIMES, THE MIDDLE TYGER TIMES and THE WOODRUFF NEWS ...all the above papers published in Spartanburg County. In addition, it appeared in THE BLACKSBURG TIMES, located in Cherokee County and in THE WHITMIRE NEWS which is a paper located in Newberry County.

April 8, 2009

Sworn to before me this  $\underline{\lambda}$  day of  $\underline{\lambda}$  2009

Notary Public for/South Carolina

Commission Expires: August 23, 2016

# SOUTHERN POWER COMPANY MAKING APPLICATION

TO

SC PUBLIC SERVICE COMMISSION
APRIL 16, 2009
FOR

CERTIFICATE OF ENVIRONMENTAL
COMPATIBILITY AND PUBLIC
CONVENIENCE AND NECESSITY

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Columbia. South Carolina 29210

Cherokee County Public Library Gaffney Branch 300 East Rutledge Avenue Guffney. South Carolina 99340

Spartanburg Public Library
Headquarters Library
15 (South Church Street
Spartanburg, South Carolina 19306

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